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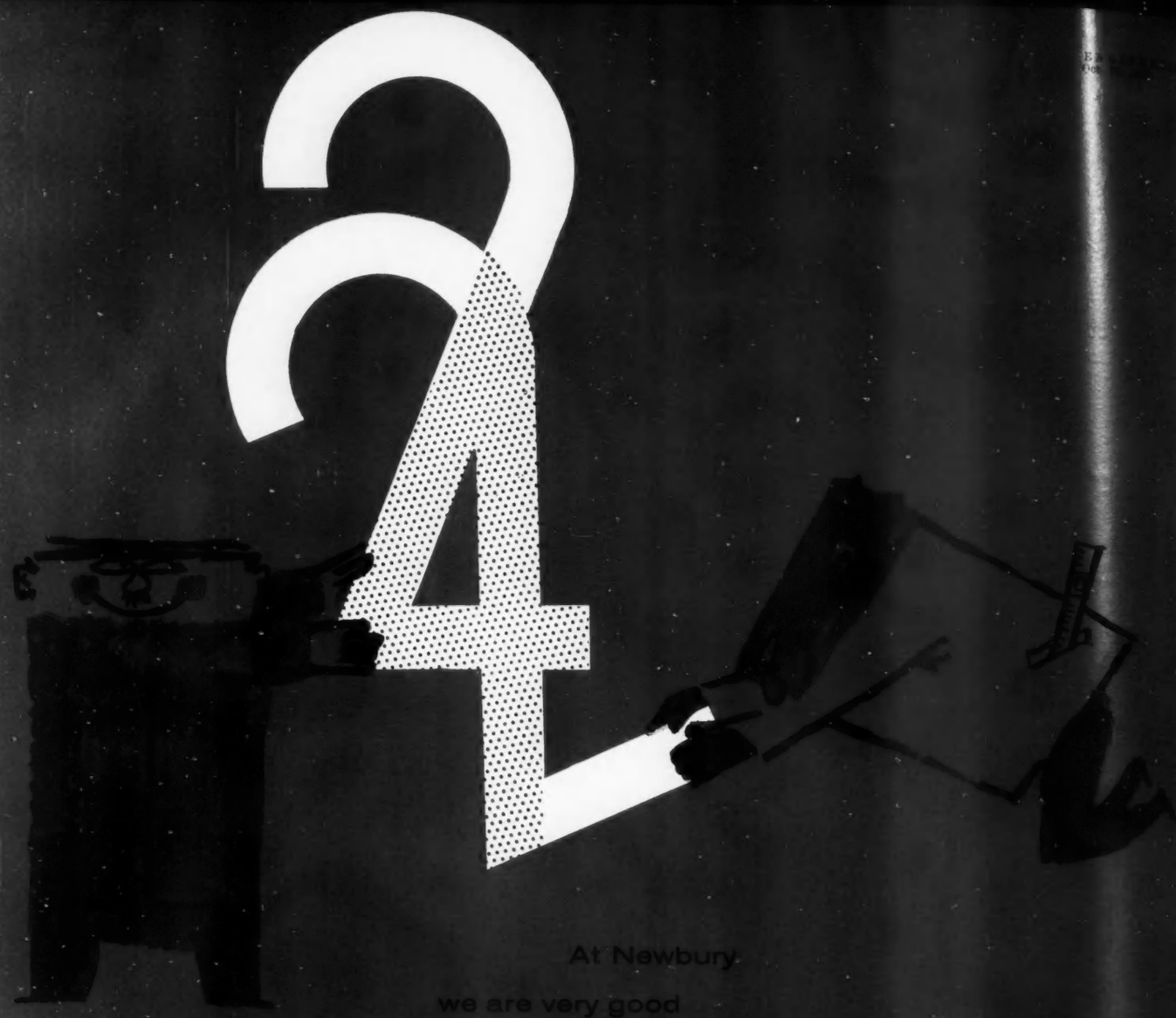

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Automobile Asymptote

SEEING new cars at the Motor Show prompts the casual visitor to extrapolate, to pick out trends and guess where cars are going. Are we, for example, approaching the limit of motor-car design? As machinery becomes more complicated two trends may be distinguished: firstly the overhaul-life potential becomes longer; and secondly the possibility of local maintenance diminishes—if faults develop there is no alternative but to return it to the makers for replacement or repair. Are these directions also true of motor cars?

Certainly overhaul life in the most general sense grows longer. Rolls-Royce recommend greasing after 10,000 miles or a year, a much longer period than has been possible hitherto. Previously they had installed a one-shot lubrication system for the whole chassis, to be operated at regular periods using a pedal inside the car; but owners proved insufficiently methodical. The company also claim that the initial molybdenum-disulphide greasing between the leaves of the rear springs is adequate for several years and may last the lifetime of the car. Rolls-Royce believe that if parts are made to fit they are bound to last much longer. But what about the less expensive cars? The Triumph Herald, using nylon-rubber bushes, has no lubrication nipples whatsoever, but is greased every 12,000 miles by way of special cups.

The limiting factor in the useful life of mass-production cars appears to be the length of time a fastening or adjustment will stay fastened or adjusted. But we do have self-adjusting brakes. Then there is the problem of chromium and enamel deterioration. At present, unless special care is taken in manufacture, surface finish does not survive more than a few years. To overcome this difficulty, the Austin A40 uses polished stainless steel and less chromium plate. Tyres since the war have been harder wearing. Engine lifetime has been considerably extended.

Mr. L. H. Dawtrey in his chairman's address to the Automobile Division of the Institution of Mechanical Engineers, draws attention to the increasing specialisation within the motor factory. Since each part of every car is some specialist's concern, can the local mechanic hope to understand the total vehicle? The inefficiency of garages becomes increasingly apparent. Are we therefore reaching the stage when for any major maintenance or repair we shall send our cars back to the makers? It seems unlikely. Standards, for example, have tackled one major problem by supplying a piston and wet-liner where previously a rebore was necessary. More probably we shall have a diminishing number of trained and appointed dealers qualified to undertake this work. But where the chassis is eliminated, a small impact may require a major readjustment of the working parts, and only a large and well equipped establishment will be capable of undertaking it.

Technical development proceeds exponentially, levelling off, as present methods are perfected, until a new principle is introduced—gas turbines, for example; then we start again, though a little higher up the ordinate. Now we seem to be at the stage when a lot of good ideas have been evolved but no one car includes them all. We have all-round independent suspension; engines near driving wheels reduce transmission losses; with the prospect of faster motorways performance is being gradually increased; safety is carefully considered, with collapsible steering wheels and disc brakes becoming much more common; on the Citroen there is air suspension, which may be adjusted to change the height of ride; perhaps we shall soon have plastics bodies with built-in galleries to convey the water from a screwed-on hose to distribution points about the body for easy washing down.

But the asymptote appears to be in sight. We already change our cars for styling not engineering reasons. This situation prompts a question. Will the demand for secondhand cars always balance the new-car requirement? Although in this country there is a substantial market for used cars, in America the Arizona Desert is full of abandoned but still useful vehicles. The 10 year test is likely to increase the problem, as does the growing practice of replacing company cars each year—used cars grow more numerous, while the demand for new cars grows.

Are we then to waste good engineering and scrap our cars before their time? Perhaps the answer is to offer private buyers the new styling with reconditioned engines—for a price concession. As the asymptote grows nearer, it will be easier to standardise the working parts between one model and its successor, and still-valid parts traded in with the old car may fit into the new. Already there is a healthy trade in glass-fibre bodies for the private individual to convert his ancient chassis. The pundits will no doubt raise their hands in horror—as they surely did when some bright young Ford executive suggested presenting the old Anglia as the new but cheaper Popular.

Regrettably such a practice will only serve to multiply the cars in Britain—so that everybody has one and we haven't any roads.

Cover Picture.—*This week nearly every section of* ENGINEERING *gives space to discussing automobile problems. The cover picture shows the engine going into the chassis of a luxury class car.*

(Nurnberg photograph for ENGINEERING*)*

Plain Words

Food is in the news. I have remarked in recent weeks how many of my colleagues have written articles on food and agriculture—from an argument that artificial irrigation is necessary, even in this country, to the report of a new process for producing palatable proteins from unlikely vegetation, such as grass. (I must admit the samples would have tasted nicer with a spot of jam.) Now that the British Association has lent its blessing by taking food as the theme of next year's meeting the subject may receive the attention it deserves. Food provision, taken for granted and muddling through, may one day be handled with the same forethought and technical efficiency as petrochemicals. But what of present-day reality?

Looking from my window in Bedford Street, close by the overflowing edge of Covent Garden, I can watch the seething plexus of London's fruit and vegetable trade. Four men stand arguing around a lorry, half-loaded and jammed astride the narrow street. Porters with handcarts, lorry drivers, private motorists and harassed policemen, ankle deep in vegetable waste, debate the possibilities of locomotion. Here then is the reality of food supply.

To counter this confusion, a systematic study is urgently required. If engineers are prepared to play a growing part in this most basic human need, there may still be hope. Dairy and agricultural machinery, food processing and canning, bulk transportation and preservation are advanced but isolated areas into which engineers may venture. But an overall technical outlook is even more important—a food-accounting operational research. But first must come a comprehensive course of training.

So far, there are no university chairs of food engineering in this country, though textile engineering and other special subjects are amply catered for. We now have a National College of Food Technology, well equipped and beautifully housed, but its interest is essentially confined to the processing of food. The college offers postgraduate and full-time instruction, together with a sandwich course—presumably to relieve the embarrassing hiatus between the soup and fish. But food deserves consideration on an even broader basis.

How sensitive is the mechanism that feeds a city of eight million people? What minor interruption could destroy its rhythm? What small increase in population could choke its channels of supply. Now the drought is over we may be faced with famine, famine that engineering methods could certainly prevent.

But one section of the British Association does not propose, I hear, to join the food symposium—the Engineering Section.

CAPRICORN

Weekly Survey

And Now Back to Work

That steel and the appropriate parts of road haulage will not now be re-nationalised is a significant, but not the only meaningful, effect of the election on the engineering industries.

As the mainspring of the national export effort the engineering industries are particularly aware of the adverse effect on foreign orders of delays and price increases caused by upsets in industrial relations. Throughout the 1950's, with the small parliamentary majorities that followed the period of the first Labour post-war government, the affairs of the trade unions have been a subject on which neither party was prepared to make the first move. Now that it seems likely that we will go through almost the first half of the 1960's with a Conservative majority in three figures, it is quite possible that if the conduct of the trade unions affects the progress of the country's industries it will be dealt with just as any other adverse factor.

But there is no suggestion yet that any Government action is needed or contemplated. Mr. McLeod has said that it is up to the unions to deal with their problems. The Conservative manifesto spoke of inviting " representatives of employers and trade unions to consider afresh with us the human and industrial problems that the next five years will bring " and Mr. Macmillan has suggested beginning the new Parliament with another look at these matters " in a friendly way."

What is certain is that responsible trade union feeling is for reaching a greater regard for negotiated agreements and the use of the proper machinery among rank and file members; for improving the unions, internal relations between members and officials where this is needed; and for getting to know more about the effects of minority political groups fighting each other with strikes as a weapon. For the trade unions there is now a situation where the Labour Party can make itself felt as an Opposition by its ideas and the value of its policies in the new decade, and no longer by its votes. If the effect of the changed position is that the trade union leaders draw closer to their members, it could be that the benefit to industrial relations will be considerable and that this country will escape the anti-union public opinion active in the United States.

The settled political outlook, which must have its effect on the swiftly moving progress of the Outer Seven trade area plans, is reflected equally at home where increased investment in machine tools is expected in the industry as further instalments of Mr. Butler's doubled standards of living are prepared. For the steel industry, with its capital investment running at £100 million a year, the intense activity in its shares and the election result should make it easier to raise money from outside sources.

For the areas where unemployment remains high, there is Mr. Macmillan's statement that new powers will be taken for remedying this. There is also the political reminder that what crumbs of comfort there were for Labour in the election came from Lancashire and Scotland.

A Shadow on the Car Boom

The Motor Show this year comes at a time when the motor industry is accelerating the pace of its development in racing car fashion. The half yearly results from Fords show the power of the demand and the effects of new capital equipment. The public reaction to the new British Motor Corporation baby cars, with salesmen still trying to persuade people to leave their showrooms late into the night, hints at untapped possibilities, and not only at home in this country.

Yet the BMC baby cars have had an unlucky arrival in the world that is full of significance for the British motor industry. In the first six weeks of its production-line life, output was halted by strikes—first of the BMC men themselves on pay questions directly concerned in making the cars, then the " against the union " strike of the British Oxygen men, cutting off a raw material as vital as steel itself, and then, briefly, the trouble at the key Lucas firm.

The latest figures show Britain selling in eight months of this year as many cars in the United States as throughout last year. But they also show the French catching up fast with the Germans, our immediate rivals. Breakdowns in the supply line are not only damaging in themselves; when they are strike-caused they are valuable propaganda material for our competitors.

When the technical achievement of the BMC departures can be blunted in its impact by such a run of labour troubles—even though fortuitous—emphasis is unavoidably thrown on two needs; that of the straight forward application of as much management skill to agreeing as far as possible rates and conditions before the new operations begin as is applied to the problems of equipment, and that of the trade union leadership to put the relations within its own house in order. The public standing of the unions will not long survive a situation where men are led into a strike, for what reason they know not, against an agreement of whose details they are ignorant.

How You Fare

The first full survey into the earnings of a representative sample of professional engineers has been published by the Engineers' Guild. Carried out by the social survey department of the Central Office of Information for the Guild and the Royal Commission on Doctors' and Dentists's Remuneration, the report (see Human Element for details) suffers from being three years old in its figures. This is not as bad as it looks since the relative position of engineers in relation to other professional men is not thought to have altered in the interval.

Next year the Guild, if it receives enough support, will be making another inquiry over a smaller sample (this one was of 6,137 corporate members of the three main Institutions) and drastically cutting the time lag. Meantime the Guild's secretary, Mr. J. G. Orr, is making an exhaustive tour of the country expounding to members not only what the survey means but what ought to be done about it.

Sixty Years On?

With the jubilee conference of the National Society for Clean Air opening at the Seymour Hall, London, on Tuesday (20 October) it is reasonable to wonder which of our other great national nuisances will in 60 years time be well on the way out.

As the Coal Smoke Abatement Society, the clean air enthusiasts began their work 60 years ago and now, with Sir Hugh Beaver taking on the presidential seat from Dr. R. Lessing, and the last provisions of the Clean Air Act now in operation, it is reasonable to feel that time and the energy of the society's members will expose the most grimed of our cities to the sun and to the eyes of the inhabitants. Now that the curious assumpton of officialdom has been dispelled, that new oil-fired heating equipment could be assumed to be smokeless but an equally new coal-burning fitting could not, the oil, coal, gas, electricity competitors in re-equipping works

and homes for the clean air age start equal—at least from this angle.

The achievements of the clean air campaigners are to be applauded, and not only for lifting the veil from our cities and making us all healthier, happier and no doubt more efficient. As the tourist income from foreign visitors grows, so may the standards demanded by the visitor and if the rain cannot be kept off him (in most summers) it will help if the soot can be taken out.

At the four day conference and exhibition itself, sessions on clean air legislation and its administration, technical papers and reports, discussion of public opinion, international co-operation, education and research, will be relieved by an evening reception at the City of London Guildhall and followed by visits to research and industrial establishments.

Practising Teachers

The stimulating idea that the best engineers and technologists from industry and Government establishments should also teach, was underlined by Sir Willis Jackson, F.R.S., in his presidential address to the Institution of Electrical Engineers.

Taking as his title, "The Making of Professional Engineers," Sir Willis, who is director of research and education, Metropolitan-Vickers Electrical Company Limited, thought there was still a tendency for our schools, universities, technical colleges and industry to be regarded as separate compartments. Not seeing them as dependent upon each other, in a continuous educational process, was the cause of certain outstanding weaknesses.

The teaching of technology could not be carried on at its highest level by men in full-time teaching unless they returned to an industrial environment at suitable intervals. Raising the technological teaching of this country to the level now needed demanded a much greater mobility of staff between educational institutions and industrial or Government establishments than that so far achieved. Carefully selected men should be fully recognised members of both educational establishments and those of industry or Government.

Acute interest is likely to be stirred up by the President's suggestion that this adoption of a practice long venerated in medicine should start with the recognition in this direction by universities of the research establishments of the Department of Scientific and Industrial Research and some of the research associations. Sir Willis described as national handicaps of great seriousness the separation of the DSIR establishments from the realm of technological teaching, and the lack of a recognised link between them and the universities in scientific and technological research.

General agreement is likely to be accorded to his point that the shortage of industrial training facilities has become the Achilles' heel of the plans for development of technical education. The new President saw the only possible solution in the cooperation of the smaller and more specialised firms in organisation of group schemes.

On the shortage of scientists and technologists generally, Sir Willis thought that some may be performing duties that, with replanning and fuller use of computing and other techniques, could be done by others less well qualified. This itself would call for numbers of those "of lower qualifications." In stressing the shortage, Sir Willis believed we had given too little recognition to the contribution, and not enough attention to the educational needs, of the technicians and craftsmen.

Calling on senior members of the engineering and like professions to do all they can to prevent waste of strength through unnecessary duplication of research, design and development effort, Sir Willis said that not only had the scientist and engineer become the guardian of the national economy, they were teachers and advisers in the industrialisation of the underdeveloped countries and must gain respect as ambassadors of broad vision, sound judgment and unquestionable integrity.

Steel Struggle in the States

As the American steel strike, by now a quarter of the year old, begins seriously to threaten employment, last minute efforts at mediation are being made in Washington in an attempt to avert a compulsory 80-day return to work under the Taft-Hartley labour law.

Such a truce is meant as a cooling down period, but such are the tensions in this situation that the 80-day spell has been described as likely to be "a hotting up period." If the American strike were simply a struggle over how large a wage increase should be paid it might well have been settled months ago.

But the Steelworkers' Union is not only fighting to raise the employers' bid a few more cents on the hour. Back at the start of the negotiations the employers proposed that the wages talks should be double-edged—the union seeking more pay for its men, the employers seeking changes to improve operating efficiency. This would involve changes in the Section 2B of the steel men's contract which covers conditions, numbers of men on a job, even how far the management can go in moving men from place to place in a works. Union opposition was instant and loud, and loudest of all over the proposed addition to the Section 2B of these words—"nothing in this contract shall prevent management from improving the operating efficiency of its plants."

Dave McDonald, the president of the steelworkers, has denounced these proposals and now says that even if a return to work under Taft-Hartley is ordered by President Eisenhower it will bring no permanent peace to the industry.

On this side of the Atlantic last month's opening of the wages negotiations in the engineering and shipbuilding industries carried an echo. Faced with the demand for substantial increases and shorter basic hours the shipbuilding employers tentatively suggested that the unions discuss a new demarcation agreement as a step towards preventing future "chalk-line" strikes. Mr. Frank Foulkes, communist president of the Confederation of Shipbuilding and Engineering Unions, replied that the CSEU representatives were not competent to discuss this. He suggested that the employers address themselves to particular unions, not all of whom were represented.

The employers are now gathering the views of their members in order to reply in mid-November. It is not likely that the last has been heard of making these talks a two-way street.

Group Apprenticeship

Among the most interesting of over 100 stands at the Engineering Industries Association exhibition (Royal Horticultural Society, New Hall, London, SW1) are those of the Engineering Industries Group Apprenticeship scheme. The scheme was begun in West London in 1954 and is now supported by 250 small and specialist firms with 500 apprenticeships between them.

The joint problem out of which EIGA grew was the obvious inability of the small firm to give one apprentice a wide and balanced experience. Apprenticeship tended to be concentrated in the largest firms, with the result that smaller firms did not find the best trained men joining them. Equally important, the feeling grew up in the smaller firms that something should be done to help in the training of a skilled labour force. The outcome of all this was EIGA, which now has 17 groups spread about the country. By pooling their resources, a range of training equal to that of some much larger units is capable of being used by apprentices.

Letters to the Editor

GAS COOLED REACTORS

SIR, I have read with a great deal of interest your Atomic Review article "Departures in Gas Cooling," on page 156 of the 11 September issue of ENGINEERING and would like to thank you for the very generous coverage you gave to the Daniels-Boyd Nuclear Steam Generator.

Since the writing of our paper for the Fifth Nuclear Congress (preprint V-54), we have evolved a very simple gaseous fission product scavenging system for the D-B NSG. This can be incorporated without compromising the basic design in any way, and is described in two information sheets, obtainable from us, which should be read in conjunction with preprint V-54.

A gaseous fission product scavenging system, when used in conjunction with fairly impervious fuel channel tubes and an *average* fuel temperature of less than 2,500° F, will, according to Oak Ridge estimates, reduce the activity in the cooling gas by several orders of magnitude. Thus, I now refer to the D-B NSG as having only a *mildly* active circuit.

A large and slightly enriched ceramic reactor with an effective scavenging system has some very real safety advantages. It has the large heat sink of such reactors, which is very effective in limiting temperature rises consequent upon coolant flow interruptions, loss of coolant pressure or power excursions. The uncanned ceramic fuel and graphite moderator can easily tolerate such temperature rises. Finally, if a major pressure circuit failure were to occur, the amount of activity released to the atmosphere would be small (due to the majority of the gaseous and volatile components having been extracted) and might even be considerably less than from a Calder Hall type in which sheath melting (with the release of some very concentrated activity) could occur.

Information sheets obtainable from us provide some interesting facts on Canadian helium. It may be noted that several fields have commercially recoverable percentages and that the gas from them is now being burned or otherwise wasted. This is a great shame when the helium is so valuable. Also I should perhaps mention that the cost of helium is not a great item in a D-B NSG which obviously must have a very gas-tight circuit; also, it only holds 1,300,000 cu. ft at N.T.P. At 10 cents per cu. ft the estimated cost is only $130,000, compared with $60 million for the entire steam generator and $100 million for the complete power station (including the steam generator). Thus, if helium cost twice or even thrice the present figure, it is still not of very major importance.

Again many thanks for the generous coverage you have given to our modest effort in the exciting field of high-temperature gas-cooled reactors.

Yours very truly,

WINNETT BOYD.

Winnett Boyd Limited,
720 Martin Avenue, Montreal 30.
5 October, 1959.

CHISWICK FLYOVER

SIR, We were interested in the article "Flyover Built into London Road Junction," appearing on page 314 of ENGINEERING for 9 October. In this connection, we should like to refer to a statement made recently by the main contracting firm for the Chiswick Flyover, the project concerned, alleging delays which affected the construction programme, and criticising the design and cost of the scheme.

Statements have already been issued by the Ministry of Transport and Civil Aviation in reply to many of these criticisms. You will appreciate, too, that as the contract is not yet fulfilled, we, as consulting engineers for the scheme, must maintain an impartial attitude as between the Ministry and the contractor and cannot comment on questions which might well prove to be matters in dispute under the terms of the contract.

Regarding the general appearance of the flyover, both we and the consulting architect

LOADER

Pry-out Force of 7,100 lb

THE latest version of the 2WL Muir Hill loader has a 50° roll-back bucket and a pry-out force of 7,100 lb—more than double the rating of earlier machines.

The loader is also fitted with a more powerful engine, the Fordson Major 3·6 litre 4 cylinder diesel, which develops 56 b.p.h. at 1,800 r.p.m. Power is transmitted through a Borg and Beck 13 in single dry plate clutch to a constant mesh gearbox giving six forward speeds from 2 to 12·6 m.p.h. and two reverse speeds of 2·6 and 4·8 m.p.h. Final drive is through a double reduction driving axle with a four pinion differential and spur bull pinions and gears. Hydraulic transmission including a torque converter is an alternative.

The height of lift under the lip of the tipped bucket is 9 ft 8 in, with 11 ft 8 in clearance under the bucket hinge. The maximum outreach is 6 ft 2 in. The maximum lift height of the beams is controlled by a limiting device to prevent strain on the hydraulic system. A range of buckets from ¾ to 2 cu. yards is available.

Operation of the hydraulic system is said to be smooth and positive, the speed being controlled by selector as required. Hydraulic power is provided by a heavy duty gear pump driven from the crankshaft by a Hardy Spicer coupling. Double acting rams of 4 in piston diameter are fitted to beams and bucket control linkages. The main beam rams provide a tearaway force of 6,500 lb at the bucket lip.

To facilitate rapid repairs on the field, hoses with reusable end fittings have been introduced. All appropriate pivot points on the frame and beams and bucket linkages have renewable lubricated bushes with the pivot pins locked by keep plates. *E. Boydell and Company Limited, Elsinore Road, Old Trafford, Manchester 16.*

SAW BENCH

Precision Cutting

THE Bursgreen 10 in sliding table dimension saw bench, list as the BGS, has been designed to operate at high speeds with high accuracy.

The saw can be tilted and the equipment includes a double mitre fence using either back or front, a straight cross-cutting fence and two interchangeable stop bars. A swivelling mitre fence which can be used at either side of the saw will give any cutting angle that may be required for angular or compound angular sawing.

The main body is a one piece casting mounted on a heavy gauge fabricated steel sub-base resting on heavy cast iron feet. The table is in two sections. The fixed table to the right of the saw is 20 in by 28 in deep; the sliding table to the left is 14 in by 28 in deep. The sliding table runs on steel rods and four grooved ball bearing rollers. It also slides back to give access to the saw.

The ripping fence runs across the full width of the table and moves on two circular section guide bars. It can be locked front and rear simultaneously by one lever. The front bar is graduated and has a screw adjustment. The saw spindle runs in sealed bearings and requires no lubrication. Rise and fall and cant are by worm and quadrant gears. The maximum depth of cut is 3 in with the saw at 90°. Dado or grooving sets to a maximum size of $\frac{6}{16}$ in by $\frac{13}{16}$ in or circular moulding cutter blocks to 4 $\frac{7}{8}$ in by $\frac{7}{8}$ in can be fitted. An extension to the table can be supplied to give a cutoff length of 80 in. There is also a fixed extension to give a distance between the saw and the ripping fence of 48 in. *Wadkin Limited, Green Lane Works, Leicester.*

Continuing Letters to the Editor

wish to point out that, in 1956, the design was discussed at length and approved by the Royal Fine Art Commission, whose members include a large number of eminent architects. This aspect of the matter is, in fact, referred to in your article.

The representative of the main contractor stated that " with a modern design, the flyover could have been built in half the time and for half the cost." He indicated that not only the main bridge over the roundabout (500 ft in length) but the whole of the approaches (a further 1,500 ft long) should have been of concrete column and beam construction, thus forming a continuous bridge or viaduct, instead of having approaches incorporating retaining walls with filling between. An explanation of every single factor that had to be taken into account in deciding on the present design would be very long, but the following are some of the important considerations:

1. When we designed the scheme in 1956, steel was in short supply and we were instructed that the minimum quantity should be used. Alternative designs and comparative estimates of cost were prepared for the approaches of (*a*) reinforced-concrete viaduct construction and (*b*) brick-faced mass-concrete retaining walls, with sandy-gravel filling behind. The latter form of construction was found to be the more economical and did not involve the use of steel. The brick facing was used structurally and obviated the use of temporary face shutters to support the wet concrete.

2. Large spans were necessary for the main bridge, owing to the position of the roundabout carriageways, other traffic requirements and the existence of a vast network of underground cables, mains and other services. Your article refers to some of this work.

3. The size of the main bridge piers was dictated by foundation conditions which affected the method of support of the bridge spans.

4. Precast concrete construction for the main bridge beams was necessary for speed of erection and to avoid the use of elaborate temporary supports and stagings across the traffic routes at the roundabout for placing in-situ concrete.

Referring to the main bridge spans, modern techniques of precast prestressed concrete construction have been incorporated and an interesting feature is that each beam is composed of three precast units assembled by prestressing. This procedure has rarely been adopted in Britain and certainly not on a structure of this size. The technique represents an important advantage of prestressed concrete; without it, precast construction for these spans would not have been possible. Far from being of obsolete design, the bridge is probably one of the largest *precast* prestressed structures in the world, and involved the solution of various problems in satisfactorily producing, conveying and erecting units of very large size, weighing nearly 35 tons each. It has proved that, in conditions where *in situ* construction is impracticable it is nevertheless possible to erect major bridge structures by making a bold and large-scale use of precasting technique. The design was to a large extent governed by the requirements of practical expediency compatible with the restricted nature of the site. Under a different set of conditions, such as in the open country, for example, a different type of design would have emerged.

We do not accept the statement that " the flyover could have been built in half the time and for half the cost," given the same site conditions and the design requirements laid down by the Ministry. Comparison has been made with structures abroad. Engineers are well aware that the design loading necessary to provide for the traffic concentrations possible in this country is heavier than abroad. In other countries, bridges of spans comparable with the Chiswick Flyover main bridge and also flyover approaches of viaduct construction are designed for substantially lighter loads. A direct comparison of the Chiswick main bridge with such structures, therefore, is hardly possible, especially if the latter have more favourable foundation conditions.

With regard to the period of construction for the Chiswick Flyover, we must emphasise the basic requirement of the police authorities and the Ministry that " all construction operations must not impede the smooth flow of traffic." We might agree that the flyover could have been constructed in much less time if it had been required in an open space with no traffic problems.

We understand that the flyover is achieving its function admirably and we are pleased to have contributed towards alleviating the serious traffic congestion at this " black " spot on the outskirts of London.

Yours faithfully,
HARRY BROMPTON & PARTNERS.

7 and 8 Hobart Place,
London, SW1.
9 October, 1959.

DESIGNING FOR INDUSTRY

SIR, We were delighted to learn that the Consumers' Association is Capricorn's pin-up society, and want to assure him that, " Design Index " sign or no, the association remains an independent institution and, with its members' help, a robust one (ENGINEERING, 25 September, page 238).

That was, in part, the point of stating plainly in the editorial of the July issue of *Which?* that the " sign has nothing to do with CA. We ourselves are not saying anything about the look of the iron or whatever it is. All we are saying is that the Council of Industrial Design likes it." To help readers of *Which?* to judge whether or not they accept the Council of Industrial Design's views on these matters, we gave a description in that issue of *Which?* of the way in which the Design Index is compiled and what exactly the sign stands for.

Yours faithfully,
(Miss) EIRLYS ROBERTS,
Editor of *Which?*

Consumers' Association Limited,
333 High Holborn, London, WC1.
7 October, 1959.

POLYPROPYLENE

SIR, My attention has been drawn to an error which appeared on page 103 of your issue of 28 August. In the paragraph on polypropylene you said that " ICI and Courtaulds are the two British companies making it in the UK." In fact, we, Shell Chemical Company, were the first to introduce polypropylene to the United Kingdom market and were closely followed by ICI. We are the only companies holding the Montecatini licence to manufacture this material in the UK.

Yours sincerely,
DAVID WOLFERS,
Press Relations Officer.

Shell Chemical Company Limited,
170 Piccadilly, London, W1.
12 October, 1959.

Editor's note: Ommission of the fact that Shell Chemical Company make polypropylene in the United Kingdom was indeed an error on our part. Courtaulds are of course, "making" it but only in the sense that they are processing the polymer into the form of extruded sheets and sections, and are spinning it into a high-tenacity yarn.

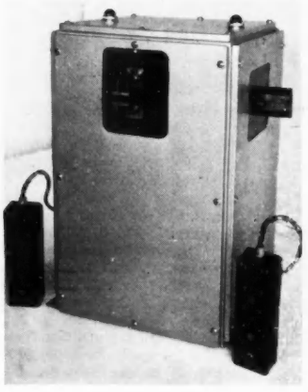
INDUCTION HEATING

Station Switch

A CHANGEOVER switch to enable two stations to be operated from a single induction heater has been produced for use with Delapena units. Low electrical losses are claimed.

The switch will handle all models up to E15/25 (which has an output of 25 kW intermittant rating) and can be remote controlled. Its object is to allow one station to be in operation while the other is being loaded, or to allow two different processes to be carried out using only one heating unit.

Apart from changing over both rf leads the switch also changes over the supply of cooling water to serve the head in use. The water is first used to cool the switch itself. As standard, the switch is supplied with two push button panels on 5 ft flexible leads, each panel having 5 buttons. This allows control of heat-on, heat-off, close, open, and master. The last named trips out the mains circuit breaker feeding the heater, and returns controls to the neutral position. The operations of the buttons are interlocked. For automatic operation the buttons can be replaced by cam-operated switches. The whole switch unit measures 17¼ in by 17½ in by 26½ in high. It weighs 100 lb. *Delapena and Son Limited, Tewkesbury Road, Cheltenham, Gloucestershire.*



TRACTOR

Mounts Digger, Shovel or Grader

THE 702 industrial tractor is a combined unit on which can be mounted a digger, a power shovel and any item that will normally attach to the three-point linkage.

The tractor is driven by the 37 b.h.p. engine that is used in the Massey-Ferguson 35 agricultural machine. A single plate heavy duty clutch is fitted. To leave the hands free a foot-operated throttle is fitted as well as hand controlled. Foot brake or foot and hand brake can be included. Within the frame of the bumper grille are the radiator and the hydraulic pump. The standard hydraulic system can be fitted if required and the pump for the digger and shovel is mounted on the front axle support and direct-driven from the engine crankshaft. Power steering is standard.

The rear mounted digger can be removed in five minutes as also can the shovel. The digger has a clear reach of 13 ft 8 in and can work down to 12 ft depth. With a trench bucket fitted it has a clearance height of 8 ft. In addition to the central mounting shown, the digger can be attached at either side to work close against a wall. Trench buckets are available in 12, 16, 20, and 24 in widths and face shovels up to 24 in. A scraper or similar item can be fitted to the three-point linkage when the digger is removed.

The power shovel can have various buckets and attachments. Standard size is 48 in wide and up to 13 cu. ft capacity. Other items include a scarifier, angle dozer, crane, and fork lift, which last will lift 1,000 lb to a height of 9 ft 9 in. *Massey-Ferguson (GB) Limited, Fletchamstead Highway, Coventry.*

MOBILE PLATFORM

Passes a Standard Door

A MOBILE working platform is now available that will straddle benches or machines yet will pass through a door of normal height.

The platform is made of low carbon steel tube welded throughout making it light and strong. It is finished in blue styrene enamel. Approach can be made from either end and the working platform reached by integral ladders. The decking is of Expamet Safemesh. The whole framework is mounted on 5 in diameter rubber tyred swivel castors which have both swivel and wheel locks fitted as standard. For uneven floors levelling jacks can be fitted.

A range of sizes is made, the platform of the lowest being at 80 in above ground level and the highest at 120 in. Intermediate steps are at 10 in intervals. The platform measures 6 ft by 2 ft and the base is 34 in wide. To enable the whole to pass through a door of normal size additional castors have been fitted on one side so that the platform is then turned on its side giving a clearance height of just over 6 ft. *Lenson Engineering Company, Churchill Road Extension, Thurmaston, Leicester.*

MOULDED CIRCUIT BREAKERS

Up to 400 A

A RANGE of small circuit breakers with moulded plastics cases has been produced to take the place of fuses.

Largest of the range is the NJ type illustrated. This is rated at 70 to 400A, 600V d.c. or 250V a.c. They have a tested breaking capacity of 10 MVA, are fitted with thermal and magnetic overloads and are made in single or triple-pole versions. The NEF type are the middle size, ranging from 15 to 100A at 250V a.c. Tested breaking current is 9,000A. The handle is trip free and the thermal magnetic overload is calibrated on manufacture.

Smallest in the range are the Stablok units, which are designed to plug into a vertical busbar and are completely interchangeable. They are made in sizes from 5 to 60A capacity and, like the others, have combined thermal and magnetic overloads, set to operate at 10 times full load current. They have an arc chute designed on the deionisation principle and have quick make and break operation. Only one outgoing terminal is used, of the screw type. The incoming terminal is the plug that engages the busbar.

Replacement of a breaker by a new one or one of different capacity is a matter of seconds. *E.C.C. Moulded Breakers Limited, Fordhouse Road Works, Wolverhampton.*

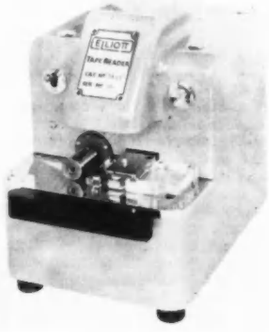
TAPE READER

1,000 Characters per second

A HIGH speed tape reader is now available for standard 5, 6, 7, and 8 hole punch tapes. It will read at 1,000 characters per sec and can stop within one character.

The characters are sensed by photo transistors which are illuminated by Perspex light guides. The transistors can be withdrawn from the instrument in one unit should one require replacement. Transistor adjustment can be effected merely by removing an inspection plate.

The tape is drawn through by a pair of rollers, the upper being fixed on the motor shaft. The position of the lower roller is controlled by an electromagnet, the amount of movement being sufficient to remove the drive from the tape when desired. The tape also passes through two flat surfaces, the pressure between them being controlled by a second electromagnet and providing a braking action which overrides the pull of the rollers. The instrument is supplied with lamp but does not contain any control circuits. It will work from standard mains voltages that is at 240 V or 115 V, at 50 or 60 cycles and requires a 12 volt supply for the lamp and a supply of less than 20 V for the transistors. The electromagnets will operate on 100 mA d.c. *Associated Automation Limited, 70 Dudden Hill Lane, London, NW10.*



GRAPHITE CONDENSER

For Corrosive Vapours

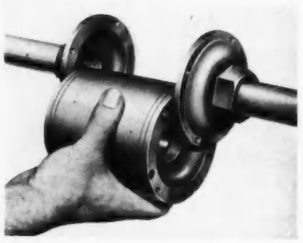
A CARTRIDGE condenser has been produced for handling corrosive vapours using graphite as the element.

The graphite element is cylindrical in form and is equipped with holes along the major axis down which the vapour passes. The service fluid passes in counterflow through the annular space between the steel jacket and the slotted outer surface of the graphite cartridge. Carbon inlet and outlet heads complete the assembly. The steel jacket can be lined with inert material if the service fluid used is other than water.

Impregnated graphite is resistant to attack by most acids, alkalis, and solvents up to a graphite temperature of 180° C. Strongly oxidising compounds are not suitable in these condensers, particularly if at elevated temperatures. Eight sizes are made ranging from 4 sq. ft surface area to 200 sq. ft. Working pressures up to 75 lb per sq. in can be used. *Powell Duffryn Carbon Products Limited, Springfield Road, Hayes, Middlesex.*

CIRCULATING PUMP

Hot Water Systems



THE Daxel pump is a British made and designed unit for circulating water in domestic heating systems. The pump is suitable for use with boilers producing up to about 100,000 Btu per hour.

Both ends of the pump screw directly into the pipework; there are no flanges to bolt up. However, it is possible to remove the central portion for cleaning, without any disturbance. A filter is fitted integrally on the incoming side. The water passes through the filter and then the hollow shaft of the pump to the radial impeller. The direction of rotation is immaterial; the operation is as efficient for either direction. The consumption is about 80 watts.

To ensure silence the stator is made free to oscillate about its own axis. Any electrical vibration is absorbed by this torsional oscillation. The pump is also very compact. It measures 4½ in diameter and 8½ in long overall. It weighs 15¼ lb. As a result it needs no other support than the pipework. It can be fitted in any position, horizontally, vertically, or at any inclination. The standard branch size is 1 in BSP but is easily replaceable by other sizes. The motor is rated for 200/250 volts supply as standard. The pump is rated at a discharge of 2 to 8 gallons per minute against heads of 8 ft and 1½ ft respectively. The unit will withstand pressures up to 25 lb per sq. in static and temperatures up to 180° F. For a temperature drop of 20° F in the water circulated, the flows quoted represent heat dissipations in the system of 24,000 and 84,000 Btu per hour. *Rhodes, Brydon and Youatt Limited, Waterloo Engineering Works, Gorsey Mount Street, Stockport.*

ANGLE GRINDER

9 inch wheel

LONG life under heavy duty is the chief claim for the Black and Decker angle grinder.

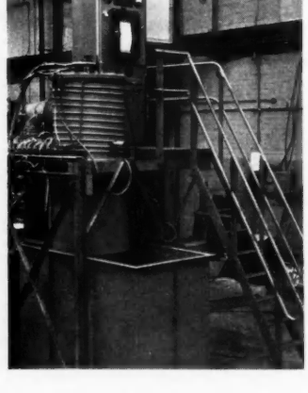
The basic model can be adapted to take 7 or 9 in sanding discs, saucer grinding wheels, wire cup brushes or planer heads. The higher speed models are specially designed for use with 7 or 9 in cut-off wheels and depressed centre grinding wheels. Three models having different spindle speeds are made. These speeds are 4,200, 5,200 and 6,000 r.p.m. The spindle diameters are ⅝ in, threaded 11 t.p.i. The overall length of the tool is 18 $\frac{3}{16}$ in and the weight 14 lb.

The gears consist of matched spiral bevels running in a completely enclosed grease filled gearcase. All ball bearings are dust and grease shielded for long life. The fan is an impeller type which is said to give efficient cooling for the motor, a more powerful one than in earlier models. It has a dynamically balanced armature and diamond turned commutator. The switch mechanism is nylon insulated and can be locked on for continuous running. The main casing is a pressure die casting of aluminium.

To give a quick and easy change of accessories the spindle has a locking hole for the locking pin. Standard equipment includes three sanding discs; 5 in rubber pad; a Koolflex backing pad; a reversible side handle and a stand. Accessories include a range of brushes, depressed centre wheels, saucer grinding wheels, adaptors and guards. On test the tool has run for 540 hours without attention or showing any internal collection of dirt. *Black and Decker Limited, Harmondsworth, Middlesex.*

VACUUM FURNACE

Molybdenum Heating Windings



A VACUUM furnace which can produce a temperature of 1,500° C at a vacuum of 10^{-4} mm of mercury uses molybdenum heater windings.

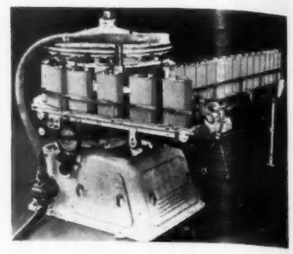
A sequence switch is used to give automatic cycling and a series of hand switches are also fitted for controlling each operation separately. The pumping system comprises a 10 in oil diffusion pump with a capacity of 2,500 litres per sec. at 10^{-4} mm Hg backed by a 48 cu. ft per min mechanical pump. All valves are controlled pneumatically.

The hot zone is 24 in in diameter and is 30 in high. It is insulated by radiation shields and water cooled. A recorder controls the temperatures, set first by thermocouples that are withdrawn when the charge is inserted. Under the bottom door of the furnace is a sealed hood leading to the water quench tank below. The hood is filled with argon. When the top door is closed, a finger raises the charge basket from the bottom to allow free circulation round it.

The sequence of operations is: first stage of pumping to 0·8 mm; second stage to 10^{-4} mm; heating, to preset temperature; pump and heater off, argon admitted and charge basket dropped into quench; bottom door shut and basket recovered from tank. *Vacuum Metallurgical Development Limited, Shelford, Cambridge.*

CAN FILLER

High Speed Version



THE latest addition to the range of can-filling machines made by Mather and Platt is for fluids and is adaptable for cans from 1 gallon capacity to ½ pint.

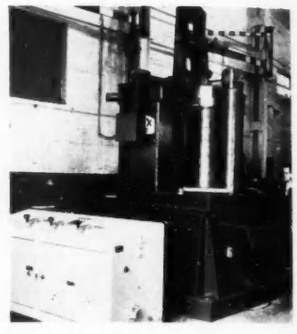
The first production model was for 1 gallon rectangular cans which could be filled at the rate of 60 per min without loss of accuracy. It is expected that smaller round containers, pint or half pint sizes, will be handled at well over 300 per min.

A rotary pump of the positive displacement type feeds the product to the filling head. The drive is enclosed in the base casting but the pump cover protrudes so that it can be removed for cleaning. The filling head normally carries 12 nozzles and is fed by the pump through a flexible tube. Parts in contact with the fluid can be of bronze or stainless steel to suit the conditions. Various nozzles can be fitted again to suit the characteristics of the product being handled. A patented anti-drip device is fitted.

The cans are fed to the machine on a slat band conveyor with a pusher for flat cans or a worm for round ones. Filled containers are discharged on a straight line so the machine can easily be linked to a capping or seaming machine. The drive incorporates two variable speed units, one on the pump, to control the rate of flow, and one on the head, to control the throughput of cans. It is claimed that the rotary pump will handle flows from 1 gallon to a couple of ounces and will accept a very wide variety of fluids, from lubricants to jams and baby foods. *Mather and Platt Limited, Radcliffe, Manchester.*

VERTICAL BENDING ROLLS

Plate up to 1¼ in



VERTICAL plate bending rolls with a capacity for plates from ¼ in to 1¼ in thick are the latest addition to the Bronx range. They are of the initial pinch type.

The machine is said to be robust and suitable for shipyard use. A full capacity bend can be made with the plate stationary, and the rolling speed of the machine is 18 ft per minute. The vertical roll neck bearings incorporate antifriction thrust bearings to take vertical loads in both directions. These are fitted on all rolls.

The two centre pinch rolls are positively driven and the two side bending rolls are idle. Limit switches are fitted to control the travel of the side bending rolls to prevent accidental overload. A swing-down end bearing is provided to allow cylindrical work to be easily withdrawn.

Full precautions have been taken to prevent scale from fouling the main drive pinions and chock slideways. Horizontal rollers on the base plate prevent the plate being bent from falling below the bottom edge of the vertical rolls.

The control gear is mounted on a multi-motor desk panel with separate contactor gear to operate the 30 h.p. main drive motor, the two 25 h.p. side-roll adjusting motors and the 5 h.p. motor for operating the back pinch roll. The machine will take plates up to 36 in width. *The Bronx Engineering Company Limited, Lye, near Stourbridge.*

WET HOPPER

1 Cubic Yard Capacity

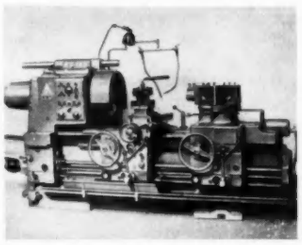
A WET receiving hopper has been produced, having a wide aperture floor and free discharge.

The design of the body is similar to that of the non-choke rollover skip already being made by the firm and is claimed to eliminate all throats and restrictions and to give an uninterrupted flow and smooth discharge.

The discharge aperture is large, measuring approximatly 20 in by 11 in and a robust, counterbalanced, gravity action door cuts off the flow of concrete as soon as the operating handle is released. A simple linkage allows the hopper to be discharged from either side and the operation is by pulling down a handle rather than, as in other models, by pushing up.

The hoppers are being made mainly in the 1 cu. yd size but smaller and larger ones can be supplied. For the standard size, the dimensions are 3 ft 7 in long; 3 ft 9 in wide; and 7 ft 2 in high. The weight is approximately 680 lb. These hoppers are primarily intended for taking dry mix concretes. *Abelson and Company (Engineers) Limited, Coventry Road, Birmingham 26.*

TURRET LATHE
Simpler Setting and Control



THE R80 turret lathe is arranged for hand operation while the RC80 capstan has programme control of the feeds and speeds. In the main, the two are identical and the R100 only differs in the size of the spindle bore.

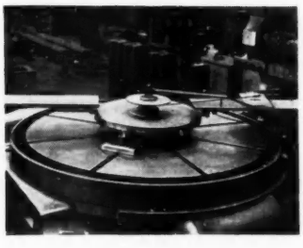
The headstock contains only the spindle and the lubricating pump. The gearbox is mounted on the bed space to avoid heating the workpiece. Radial rigidity of the spindle is said to be very high. On the R80, speeds are engaged by a single lever and on the RC80 by push button or programme control. Multiple disc clutches are not used.

The feeds of both carriages are controlled by a single lever, and a separate lever operates the rapid traverses. These are driven by a separate motor. The hexagonal turret is indexed by hand but power indexing can be fitted to order. A special attachment in the feed box allows threads to be cut, right or left hand, single, double or triple start, with a single follower. On the RC80 remote control is possible.

The hollow chuck is electrically operated and will take work of widely differing diameters. Motors set round the spindle control the clamping tube and jaws, through planetary gearing. Operation is by two switches: one sets the pressure and the other controls the opening and closing. A red light indicates that the jaws are clamped.

The lathes swing 760 mm over the bed and the chucks are bored to 80 mm. Eight reversible spindle speeds cover the range from 16 to 900 r.p.m. There are eight carriage and cross slide feeds, increased to 16 if a countershaft is used. (*Shown at the Brno Fair.*) *Strojexport, Prague, Czechoslovakia.*

TRANSMISSION TESTER
Magnetic Comparison



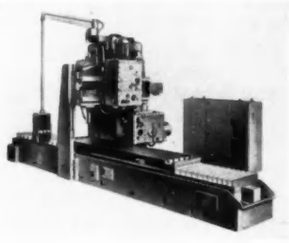
THE Research Institute of Machine Tools and Machining at Prague has developed a magnetic method by which the precision of gear transmissions can be checked while in operation.

The illustration shows the set-up for checking the transmission to the dividing table of a hobbing machine. A metal disc has on its circumference a magnetic ring on which is recorded a sine wave magnetic field of a definite integral number of waves. These may be compared to the engraved lines of a scale. The fundamental difference, however, is that the magnetic field is continuous and a position can be defined anywhere. Also the indication of the record is electrical and objective.

Magnetic scales are coupled to two members of the transmission being checked, and the measurement is made by the phase changes of the frequencies picked up from both scales. The resultant curve indicates directly the curve of the kinematic error of the transmission.

The IMO-P equipment is universal for all gear ratios within the range from 1 : 50 to 1 : 1,000. It permits any transmission to be checked between the table of the machine (equivalent to the worm wheel) and the worm, the tool spindle or any other member of the kinematic chain. The measurement is continuous. Only one revolution of the transmission is required and the time needed is therefore short so that temperature changes are eliminated. The instrument permits independent recording of the kinematic, additive and cyclic error of the transmission with an accuracy of 0·5 sec of arc. (*Shown at the Brno Fair.*) *Strojexport, Prague, Czechoslovakia.*)

MILLING MACHINE
Unit Head Construction



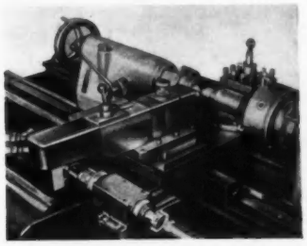
THE FRO8 milling machine is built on the unit head principle, allowing it to take various forms.

It is a single column machine with the heads mounted on the column and an outrigger. A brace supports the outer end of the latter. The whole side of the machine is open so that workpieces are not limited to the width between columns. Work up to 10 tons can be handled.

Operations can be carried out by one or more heads at the same time and can be controlled by punched cards or tape. Setting-up controls are mounted on the pendant panel. The table feed is from a Ward Leonard drive and includes a device to eliminate backlash. This device is taken out of use when the quick traverse is used. The table has a working surface of 800 by 3,500 mm (31½ by 138 in approximately) and a travel of 3,500 mm. Table feeds range from 20 to 1,000 mm per minute. The distance of the table from the vertical spindle can be varied from 50 to 1,000 mm, and between the table and the horizontal spindle from 50 to 750 mm. The table and headstocks are controlled by remote scales using a Selsyn system.

There are three sizes of headstocks, the first two of which can be used in either the horizontal or vertical positions, but the third, the largest, can be used horizontally only. The VF100 has a motor rated at 7·5 kW and a speed range from 22 to 1,120 r.p.m. The VF120 is rated at 14 kW and ranges from 28 to 710 r.p.m. or from 22 to 560 r.p.m., and the VF160 is 28 kW with two speed ranges from 18 to 560 or from 22 to 710 r.p.m. (*Shown at the Brno Fair.*) *Strojexport, Prague, Czechoslovakia.*

HYDRAULIC COPYER
Lathe Attachment



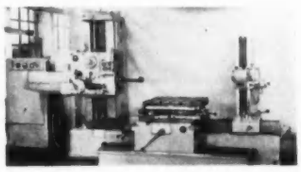
TWO sizes of hydraulic copying attachments have been developed for use with centre lathes. They differ in working stroke and size of master.

The attachment consists of the copying carriage with the distributing valve and the tracer; the pump that supplies the pressure oil and its control elements; the tailstock for taking the master; and the drive for the template and the brackets for fixing the tailstock to the lathe bed. The first three items are independent of the size or make of lathe but the last has to be adapted individually to suit.

The carriage has two self-contained units: a body with a square tail spindle mounted in roller bearings and bored for taking the height adjustable tool, and a hydraulic cylinder. The piston with a double ended piston rod is provided on one end with a built-in slide valve and on the other end it is connected by a screw to the tail spindle. The screw sets the size of the workpiece. The stylus is fixed on a carrier and transmits the movements to the distributing valve. The attachment works on the symmetric four edge twin collar principle. Both sides of the cylinder are independently supplied with oil. To give quick response the oil is supplied by two gear pumps at 50 atmospheres pressure.

The IKSV2 has a stroke of 50 mm and the IKSV3 one of 60 mm; the maximum following speed is 240 mm per sec for both. The maximum profile rising of the master is 60° and falling is 70°. Maximum master diameters are 160 and 250 mm respectively. The tracer exerts on the template a pressure between 1·2 and 1·8 kg. (*Shown at the Brno Fair.*) *Strojexport, Prague, Czechoslovakia.*

HORIZONTAL BORER
Optical Setting



THE WH63 is a horizontal boring, drilling and milling machine that can often replace a jig borer. It has optical setting to 0·01 mm.

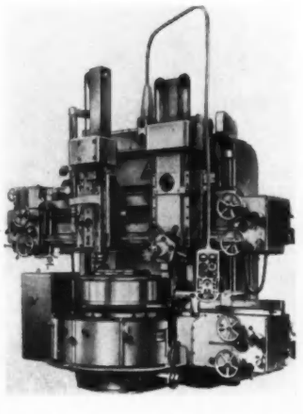
The rotary table can take workpieces weighing up to 2,000 kg. A surface measuring up to 1,000 by 710 mm can be machined from four sides at a single setting and the positions of the table are positively locked after each 90° of rotation. The machine bed is 1,480 mm broad so that the table is fully supported in all positions. Fine adjustment of the final position is by handwheel from the operator's post, from which all other machine movements are also controlled. A limit switch enables preselection of drilling depth to an accuracy of ± 0·5 mm.

Automatic feeds for both slide and spindle stock can be used together so that oblique surfaces up to 45° can be machined. Spindle speeds and feed rates can be preselected by the dials and engaged as required even with the machine running. The travel of the bearing block on the end support column is by a separate motor and precise alignment of the axis is by a handwheel.

The machine has a spindle diameter of 63 mm and can have either special or Morse taper. The maximum spindle travel is 560 mm and the vertical travel of the headstock on the column is 710 mm. The table has a cross travel of 1,000 mm and the same amount of longitudinal movement. The useful working surface is 800 by 890 mm. There are 21 spindle speeds ranging from 18 to 1,800 r.p.m. and 26 feed rates from 0·02 to 6·3 mm per rev. The rapid traverse is 1,600 mm per min.

A range of attachments is also available including angular milling fixtures and tracer units. (*Shown at the Brno Fair.*) *Strojexport, Prague, Czechoslovakia.*

VERTICAL BORER
Electromagnetic Copying



THE SK12 is a vertical boring and turning mill with a capacity for a workpiece of 4,000 kg (about 8,800 lb).

A particular feature of the machine is that it has three heads, two mounted on the cross bar and one on the column. A recent addition is an electromagnetic copying device. Workpieces up to 1,350 mm in diameter and 1,000 mm in height can be handled on the table and there are three choices of maximum table speed, namely 150, 225 and 314 r.p.m. The main drive is from a commutator motor via a flexible coupling and a four step gearbox. As the motor speed is also variable over a 4 : 1 ratio each gear is virtually infinitely variable.

Most of the machine controls are centralised on a panel and the feeds have automatic release operated by a stop system. There are 24 tool head feeds covering the range from 0·06 to 9 mm per rev.

The electromagnetic copying device works on a twin direction system and the clutches are operated from a three position tracer unit. A full size positive template is used. A six position switch allows face copying from centre to centre; cylindrical copying up and down; and internal copying up or down. (*Shown at the Brno Fair.*) *Strojexport, Prague, Czechoslovakia.*

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

LONDON
Presidential Address by Sir Josiah Eccles. London National Lecture. Manson House, 26 Portland Place, W1. Tues., 20 Oct., 6.30 p.m.

CROYDON
"Semi-Conductor Power Rectifiers," by P. S. Clayton. South London Branch. Greyhound Hotel, High Street, Croydon. Thurs., 22 Oct., 8 p.m.

NOTTINGHAM
"Electrical Safety in the Home," by S. J. Emerson. Nottingham Branch. Offices of the East Midlands Electricity Board, Carrington Street, Nottingham. Wed., 21 Oct., 7.30 p.m.

British Computer Society

CARDIFF
Conducted visit to the computer installation of the Steel Co. of Wales Ltd., Margam Works, Port Talbot. Meet at the Small Shandon Theatre, University College, Cardiff. Thurs., 22 Oct.

British Institution of Radio Engineers

LONDON
"Aviation Medicine," by P. V. Byford. Medical Electronics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 21 Oct., 6.30 p.m.*

EDINBURGH
"True Motion Radar," by J. H. Beattie. Scottish Section. Department of Natural Philosophy, The University, Drummond Street, Edinburgh. Fri., 23 Oct., 7 p.m.

GLASGOW
"True Motion Radar," by J. H. Beattie. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Thurs., 22 Oct., 7 p.m.

Central London Productivity Association

LONDON
Conference: "Computers for the Smaller Firm." Federation of British Industries, 21 Tothill Street, London, SW1. Thurs., 22 Oct., 9.45 a.m. to 4.45 p.m. (Tickets required: fees 35*s* and 45*s*.)

Combustion Engineering Association

BRISTOL
"Technical Application of Fuel Oil in Industry," by D. J. Heslop; and film on "Cyclone Firing." Western Region. Royal Hotel, College Green, Bristol. Thurs., 22 Oct., 11 a.m.* and 2.15 p.m.

Illuminating Engineering Society

LONDON
"The Generation of Light," by L. J. Davies. Caxton Hall, off Victoria Street, SW1. Mon., 19 Oct., 6 p.m. (Tickets required.)
"Light and Road Safety," by Dr. W. H. Glanville. Institution of Civil Engineers, Great George Street, SW1. Thurs., 22 Oct., 6 p.m.*

Institute of Fuel

LONDON
"Use of Oxygen in Combustion Processes with Particular Reference to the Steel Industry," by T. C. Churcher. Institution of Civil Engineers, Great George Street, SW1. Wed., 21 Oct., 5.30 p.m.*

Institute of Marine Engineers

BIRMINGHAM
"Electrical Marine Equipment," by S. A. G. Emms. West Midlands Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Thurs., 22 Oct., 7 p.m.

BRISTOL
"Marine Machinery Breakdowns," by J. H. Milton. West of England Section. The University, University Walk, Bristol 8. Mon., 19 Oct., 7.30 p.m.

CARDIFF
"Cavitation," by E. E. Williams. South Wales Section. South Wales Institute of Engineers, Park Place, Cardiff. Mon., 19 Oct., 7 p.m.

NEWCASTLE UPON TYNE
"Corrosive Wear in the Cylinder Liners of Slow Speed Marine Diesel Engines," by Miss Van der Horst. North East Coast Section. Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne. Thurs., 22 Oct., 6.15 p.m.*

Institute of Road Transport Engineers

DURHAM
"Current Developments in Tyres and Steering Geometry." by J. L. Johnson. North Eastern Centre. Three Tuns Hotel, Durham City. Tues., 20 Oct., 7.30 p.m.

EDINBURGH
"Servicing of Electrical Equipment," by J. H. Stoneman. Scottish Centre. North British Hotel, Princes Street, Edinburgh. Mon., 19 Oct., 7.30 p.m.

Institution of Chemical Engineers

LONDON
"Gas-Solids Contacting in Fluidised Beds," by K. P. Lanneau. Geological Society, Burlington House, Piccadilly, W1. Wed. 21 Oct., 5.30 p.m.*

Institution of Civil Engineers

LONDON
"Development of Gatwick Airport," by F. S. Snow and N. J. Payne. Tues., 20 Oct., 5.30 p.m.*
Informal discussion on "The Problems of Measurement on Civil Engineering Works," introduced by James Martin and B. K. Clancy. Thurs., 22 Oct., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Chairman's Address, "Remote Observation Using Closed Circuit Television," by L. A. Harris. London Graduate and Student Section. Mon., 19 Oct., 6.30 p.m.*
Chairman's Address, "Where Next?" by Dr. J. R. Mortlock. Supply Section. Wed., 21 Oct., 5.30 p.m.*

BRIGHTON
"Discrimination Between High-Rupturing-Capacity Fuses," by E. Jacks. Southern Centre. Technical College, Brighton. Wed., 21 Oct., 6.30 p.m.

EDINBURGH
Chairman's, Address by D. M. Thornton. South East Scotland Sub-centre. Carlton Hotel, North Bridge, Edinburgh. Tues., 20 Oct., 7 p.m.

GLASGOW
Chairman's Address by J. E. Sayers. South West Scotland Sub-centre, 39 Elmbank Crescent, Glasgow, C2. Wed., 21 Oct., 6 p.m.

HULL
"Cathodic Protection," by L. B. Hobgen, K. A. Spencer and P. W. Heselgrave. North Midland Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Thurs., 22 Oct., 6.30 p.m.*

LIVERPOOL
"Subscriber Trunk Dialling," by D. A. Barron. Mersey and North Wales Centre. Royal Institution, Colquitt Street, Liverpool. Mon., 19 Oct., 6.30 p.m.

NOTTINGHAM
"The Recognition of Moving Vehicles by Electronic Means," by T. S. Pick and A. Readman. East Midland Centre., College of Arts and Crafts, Nottingham. Tues., 20 Oct., 6.30 p.m.*

Institution of Highway Engineers

DURHAM
"Recent Developments in Coated Macadam and Cold Asphalt," by A. E. T. Lawrence. North East Branch. University Science Laboratories, South Road, Durham. Fri., 23 Oct., 7 p.m.

Institution of Locomotive Engineers

LONDON
"Aluminium Technology and Railway Rolling Stock," by K. P. Brockway. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 20 Oct., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Present-Day Feed-Water Treatment for High-Pressure Boilers," by P. Hamer. Meeting in conjunction with the Steam Group. Wed., 21 Oct., 6 p.m.*
Discussion on "Effects of Cavitation in Hydraulic Machinery." Hydraulics Group. Thurs., 22 Oct., 6 p.m.*

BELFAST
Repetition of Presidential Address on "The Engineer, Life and Diesel Engines," by H. Desmond Carter. Northern Ireland Branch. Belfast Museum and Art Gallery, Belfast. Tues., 20 Oct., 7 p.m.

BRISTOL
"A Modern Foundry for the Manufacture of Small Steel Castings by New Moulding Techniques," by C. B. Carter. Western Branch. The University, Bristol. Tues., 20 Oct., 7 p.m.*

CARDIFF
Chairman's Address by N. Brearley. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 20 Oct., 6 p.m.

DERBY
"Some Considerations of the Lubrication of Free Piston Machinery," by R. M. Hosie and G. M. Barratt. Derby AD Centre. Midland Hotel, Derby. Mon., 19 Oct., 7.15 p.m.

GLASGOW
Repetition of an Address on "Some Problems We Meet," by L. H. Dawtrey, Chairman of the Automobile Division. Scottish AD Centre. 39 Elmbank Crescent, Glasgow, C2. Mon., 19 Oct., 7.30 p.m.

HULL
"The Management Control of Small Engineering Firms," by L. Fontaine, W. R. Spencer and J. M. Walker. Yorkshire Branch. Royal Station Hotel, Hull. Wed., 21 Oct., 7.30 p.m.

Institution of Plant Engineers

BIRMINGHAM
"Industrial Floorings," by W. J. Warlow. Birmingham Branch. Imperial Hotel, Temple Street, Birmingham. Fri., 23 Oct., 7.30 p.m.

ROCHESTER
"Metal Spraying and Ceramic Coatings," by J. A. Sheppard. Kent Branch. King's Head Hotel, High Street, Rochester. Wed., 21 Oct., 7 p.m.

Institution of Production Engineers

LONDON
"Computers as Applied to Production Control," by B. L. J. Hart. Royal Commonwealth Society, Northumberland Avenue, WC2. Thurs., 22 Oct., 7 p.m.

DERBY
"What's New in Casting?" by A. Short. St. James's Restaurant, St. James's Street, Derby. Mon., 19 Oct., 7 p.m.

HALIFAX
"Productivity and Exports," by J. B. Scott. Halifax and Huddersfield Section. Percival Whitley College of Further Education, Francis Street, Halifax. Wed., 21 Oct., 7 p.m.

LETCHWORTH
"The Management of Men," by R. R. Hopkins. Luton Section. North Herts Technical College, Letchworth. Thurs., 22 Oct., 7.30 p.m.

Institution of Structural Engineers

LONDON
"The Design and Construction of the New Basic-Bessemer Plant at Port Talbot," by J. W. P. Jaffe. Thurs., 22 Oct., 6 p.m.*

BIRMINGHAM
Chairman's Address by A. T. Clarke. Midland Countries Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. Fri., 23 Oct., 6.30 p.m.

MANCHESTER
Chairman's Address by T. C. Waters. Lancashire and Cheshire Branch. College of Science and Technology, Manchester. Tues., 20 Oct., 7.15 p.m.

Junior Institution of Engineers

LONDON
"Some Recollections of Past Secretary H. G. Riddle as a Model and Experimental Engineer," by H. J. N. Riddle. Fri., 23 Oct., 7 p.m.*

Manchester Association of Engineers

MANCHESTER
"Design and Construction of the Latest Self-Righting Lifeboat," by R. A. Oakley. Engineers' Club, Albert Square, Manchester. Fri., 23 Oct., 6.45 p.m.

Operation Research Society

LONDON
Annual General Meeting. Royal Society of Arts, John Adam Street, Adelphi, WC2. Wed., 21 Oct., 6 p.m.*

Physical Society

LONDON
Discussion on "The 1959 Stockholm Conference on Modern Systems for Detecting and Evaluating Optical Radiation," opened by Dr. K. M. Greenland, Dr. W. R. Hindmarsh and Dr. L. Mandel, at 2 p.m. Interval for tea. The 1959 Parsons Memorial Lecture by Dr. C. R. Burch at 5 p.m. Optical Group. Science Museum, Exhibition Road, SW7. Thurs., 22 Oct.

Royal Institution

LONDON
"How Can We Help Underdeveloped Countries?" by Sir Norman Kipping. Fri., 23 Oct., 9 p.m.

Royal Statistical Society

SHEFFIELD
"Experiments in Telepathy," by Dr. S. G. Soal. Sheffield Group. Grand Hotel, Sheffield. Thurs., 29 Oct., 7 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Energy Requirements in the Heating and Re-Heating of Semi-Finished Steel Products," by H. Southern. Joint Meeting with the Sheffield Society of Engineers and Metallurgists. Engineering Lecture Theatre, The University, St. George's Square, Sheffield. Mon., 19 Oct., 7.15 p.m.
"Whither Refractories?" by Professor J. White. Refractories Group. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 20 Oct., 7.30 p.m.

Society of Chemical Industry

LONDON
Fourth Baekeland Memorial Lecture: "Recent Progress in Polymer Chemistry," by Professor H. Mark, Director of the Polymer Research Institute of Brooklyn, New York. Royal Institution, Albemarle Street, W1. Thurs., 22 Oct., 6.30 p.m.

Society of Engineers

LONDON
"The Dissemination of Technical Information with Particular Reference to the Aircraft Industry," by K. A. Steel. Geological Society, Burlington House, Piccadilly, W1. Mon., 2 Nov., 5.30 p.m.*

Society of Instrument Technology

LONDON
"Modern Developments in Optical Instruments," by J. H. Bach and G. E. Fishter. Manson House, 26 Portland Place, W1. Tues., 27 Oct., 7 p.m.*

BRISTOL
"Feedback," by R. S. Medlock. Bristol Section. Department of Physics, University of Bristol, The Royal Fort, Bristol 8. Tues., 20 Oct., 7.30 p.m.

NEWCASTLE UPON TYNE
"Automatic Control of Space-Heating and Air-Conditioning Plant," by D. H. Powell. Newcastle Section. Roadway House, Oxford Street, Newcastle upon Tyne. Wed., 21 Oct., 7 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
Presidential Address by J. W. Todd. Fri., 23 Oct., 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor at least three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927)
British Computer Society, Finsbury Court, Finsbury Pavement, London, EC2. (MONarch 6252)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Central London Productivity Association. Apply to Mr. B. E. B. Turner, Shell-Mex & B.P. Ltd., 1 Kingsway, London, WC2. (TEMple Bar 8456)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871.)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Manchester Association of Engineers, 18 Booth Street, Manchester 2. (Central 1717)
Operational Research Society, 64 Cannon Street, London, EC4. (CITy 1800)
Physical Society, 1 Lowther Gardens, South Kensington, London, SW7. (KENsington 0048)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Statistical Society, 21 Bentinck Street London, W1. (WELbeck 7638)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)

What Engineers Earn—First Full Survey

What scientists and engineers think of the lip service paid daily to their essential importance to the future of Britain is best seen in the steady stream of emigrants leaving our shores. Now the simple financial facts, of inadequate pay, promotion ladders neither steep enough nor long enough, and the immense disparities between the standards of Canada and the United States and those of this country, are made plain in a survey of the earnings of 6,137 members of the Institutions of Civil, Mechanical and Electrical Engineers, carried out by the social survey division of the Central Office of Information for the Engineers' Guild.

Most serious of the findings is that in 1956, the period of the survey, half the professional engineers in this country earned less than £1,200 and 30 per cent under £1,000. From the survey returns, the median income for engineers is shown to be below the figure of £1,200.

The number of engineers who reached more than £1,600 was only one in four, and in the age group 40 to 54, which is taken as covering most peoples' highest earning period, more than 63 per cent were paid less than £1,600.

The Lure of the States

At a time when the importance of highly qualified engineers in all branches of industry, in nuclear energy, in transport and in defence is constantly stressed, the comparison with North American remuneration is an urgent challenge. In the same year (1956) the Engineers' Joint Council, an organisation of the principal American engineering societies, surveyed engineers' incomes. The Council showed that only one in ten of American professional engineers was earning less than £1,625 a year after graduation. Half the engineers earned more than £2,250 at the age of 25 and they had moved on to £2,750 at 30. This means that of American engineers 90 per cent were on a higher salary at the age of 22 than three out of four of their British counterparts attained in the whole of their careers.

It is the same depressing story when comparison is made with Canada. The 1956 survey of salaries by the Association of Professional Engineers in the province of Ontario gave the earnings of half of all the engineers there one year after graduation as over £1,700 a year; £2,000 four years after graduation, and £2,600 nine years after graduation.

Even at home, where the relative living standards of all professional groups have declined since the inter-war years, the figures show engineers at a disadvantage with other professions whose qualifications require similarly arduous studies.

Since 1956 there is little to suggest that the engineer has improved his place on the scale in relation to others in this country, and no evidence at all that abroad the reward for engineers is standing still. The average starting salary of 96 engineers who graduated last year from the Technological Institute of North-Western University, Evanston, Illinois, USA, was just over £2,150 a year.

A Depressed Profession?

The obvious effect of the standard of reward of British engineers—the emigration of a significant number of qualified men and not all of them to the Commonwealth—is not the only one and perhaps not the most serious.

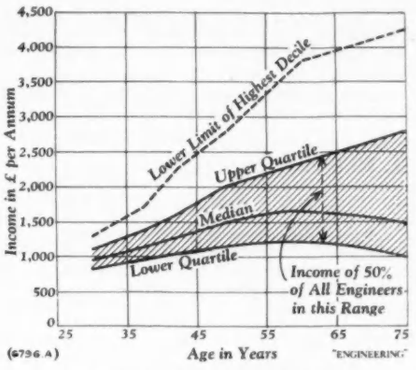
When average salaries are what this survey shows them to be, it is well within the bounds of possibility that careers masters and parents will try to influence the brilliant boy, or any child, into those professions where the chances of rising to the heights are greater and where the standards achieved by the rank and file are a better reward for the period spent in preparation. There is even the further effect on the contribution made to the growth of the nation's industries by a body of engineers, many of whom actively feel themselves underprivileged in relation to the responsibilities they carry. Lack of incentive and recognition may have the same effect on the economy as a wasting disease.

An unimpeachably professional job, the survey was carried out jointly for the Guild, who publish the results in the current number of their journal *The Professional Engineer*, and the Royal Commission on Doctors' and Dentists' Remuneration. A one-in-five sample was drawn at random from the 1957 lists of the corporate members of the Institutions of Civil, Mechanical and Electrical Engineers. For a variety of reasons, including 2,010 "no replies" and 27 who replied that their income was not known, the final number of questionnaires used was 6,137.

Very Good at the Top

Two conclusions emerged quite rapidly. For a very small percentage it could be said that the reward from outstanding success was highly satisfactory. Of all engineers the percentage earning above £3,000 a year in 1956 was shown to be 5·2, and above £6,000 it was 1·2. But as a quick glance at the graph will convey, in the words of the Guild—"it is equally clear that qualification as a professional engineer is no guarantee that a person's income will ever rise much above that of a skilled technician."

Between the Institutions it appears the main concentration of Civils was in the bracket £800 to £999 while the Electricals and Mechanicals had their main grouping over £800 to £1,199, with the Mechanicals tending towards the upper half of this bracket. If the Civils had their largest group in the lower category, at least they had before them the largest carrot of incentive in that above £6,000 there were more than twice as many civil and mechanical engineers as electrical, although the total strength of the Institution of Civil Engineers is about half of that of either of the others.



Income distribution by age.

Income in £ per Annum	Percentages All Ages
Under 800	7·6
800–1,199	43·9
1,200–1,599	23·5
1,600–1,999	10·6
2,000–2,399	5·8
2,400–2,799	2·7
2,800–3,199	1·6
Over 3,200	4·3
Total	100·0

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Percentage income distribution.

Propaganda in a number of media on early reward for exceptional talent is not borne out by the facts now revealed. In the 30-34 age group the number above £2,000 was only 17 but included two who had exceeded £4,000. As would be expected, better chances of really high income are shown to exist in industry and commerce but an interesting comparison is possible between the Civil Service and local authorities. Of the 754 engineers in the Civil Service, the younger age groups tended to be earning more than contemporaries among the 606 with the local authorities. Once above the £2,200 a year line, there were only 29 civil servants against 37 local authority engineers. Over £2,800 the civil servants had only 4; the local authorities 8 and the 577 engineers in nationalised electricity could show 12.

A Grave Warning

Outside the report's terms of reference, but perhaps a weakness for all that, is the complete absence of any information on the responsibilities carried by the engineers surveyed. Without such details it is possible to wonder whether British engineers are not only being underpaid for the work they do but underestimated in the work they are allowed to do.

Comment on the survey has been made by the chairman of the Engineers' Guild, Mr. J. H. Jellet. He calls its results "A grave warning to the government, industry and the country. If this situation is allowed to drift, then the recruitment of professional engineers must decrease: if that happens then the efficiency—and the prosperity—of British industry will steadily diminish."

Characteristics of the Income Distributions

	Number of engineers	Lower quartile	Median	Upper quartile	Highest decile
		£	£	£	£
All in Great Britain	6,137	950	1,181	1,600	2,268
By age:					
Under 35	1,807	837	953	1,110	1,300
35 to 39	1,075	965	1,142	1,376	1,728
40 to 44	909	1,040	1,281	1,659	2,250
45 to 54	1,502	1,150	1,484	2,000	2,771
55 to 64	690	1,216	1,652	2,305	3,803
65 and over	130	990	1,467	2,800	4,273
By certain main occupations (excluding those with any subsidiary occupation):					
In private practice alone or in partnership	89	1,725	3,368	6,712	12,082
Salaried employees in consulting firms	264	901	1,050	1,437	1,928
Teachers and salaried employees in other types of professional engineering employment	5,157	949	1,186	1,596	2,200
In salaried employment, but not as engineers (included as teachers, etc. in line above)	237	1,190*	1,620*	2,470*	3,550*
Field of employment with and without subsidiary occupation:					
Commerce and industry, excluding nationalised industries and UKAEA	2,533	951	1,181	1,650	2,411
Transport	138	891	1,065	1,599	2,040
Electricity	577	908	1,085	1,350	2,007
Selected nationalised industries:†					
Civil Service	754	1,066	1,265	1,545	1,862
Local Authority (except teachers) and public utility	606	824	968	1,360	1,955

* Approximate. † In the coal, gas and atomic energy industries the total number of completed questionnaires was insufficient to provide reliable medians, etc.

Acceleration in Minor Key

ACCELERATORS find other application besides smashing small particles to smaller pieces, and they are not always the costly machines described in last week's issue of Atomic Review. Some lower energy accelerators and their use in industry and medicine are described below.

Sextet of Applications

Lower-energy particle accelerators usually serve as injectors to high-energy machines. In industry, interest in the development of portable accelerators for the radiography of heavy steel sections has been stimulated by the nuclear power programme. One of the limitations of the thermal rating of gas-cooled graphite-moderated reactors is the maximum plate thickness that can be radiographed in the field. Even though plates to a thickness of 13 in can be welded, a satisfactory radiograph with a 4 MeV accelerator requires an exposure time of one hour. In medicine, accelerators are used as a source of ionising radiation for the treatment of cancer, and the production of short half-live isotopes such as carbon 11, and oxygen 18. The fast decaying isotopes are used as radiation sources and are placed inside the tumor which is to be destroyed. Owing to the very short half-life, these isotopes must be produced in the hospital at the time of use, and accelerators have served for the purpose. The particle beam of an accelerator may also be used for cold sterilisation in non-continuous processes where the use of large isotope sources is not justified. Finally, in research, particle accelerators are used in radiochemistry to investigate the effect of rearranging chemical bonds in polymers. D. R. Chick and C. W. Miller in their article "Particle Accelerators and their Applications," first published in *British Communications and Electronics*, vol. 3, No. 10, also mention the possibility of using accelerators as large power sources for short wavelength radiation of the order of millimeters. The method utilises radiation emitted by energetic particles subjected to acceleration forces.

Injector of Argonne ZGS

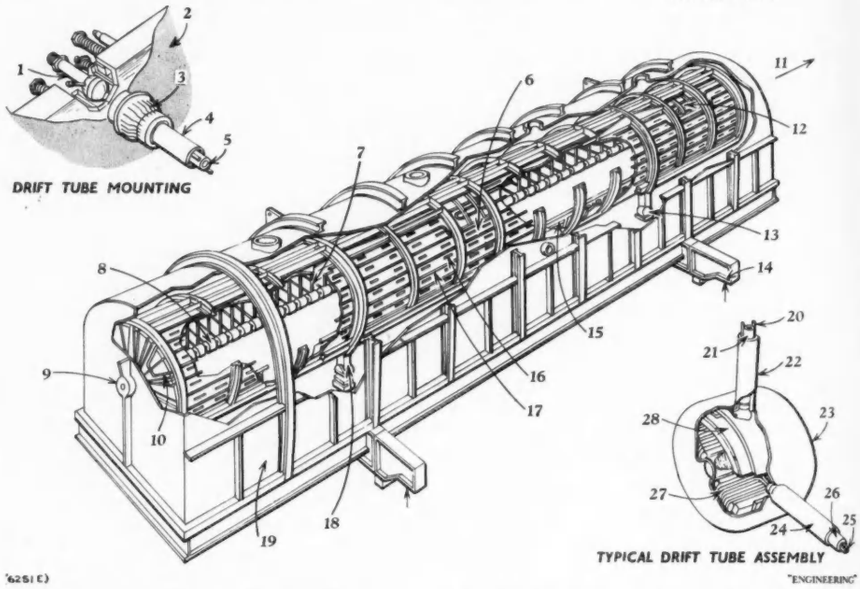
The proton beam of the Argonne zero-gradient synchrotron (Atomic Review, 9 October, 1959) is accelerated in two stages to 50 MeV before injection into the magnet ring. The principle of injection is necessitated by the difficulty of maintaining a uniform magnetic field of low strength in magnets which must also be capable of producing much stronger fields as the particles are accelerated. A sledge hammer cannot be used to chisel a cameo, and it is necessary to start with particles of considerable energy in the synchrotron. At Argonne the pre-accelerator is a combined ion source and 800 kV Cockcroft-Walton device, which feeds ion pulses to a 50 MeV linear accelerator. The resonant cavity of the linear accelerator is 110 ft long with 124 drift tubes and focusing magnets. The pulsed power supply is of radiofrequency, with a peak power of 5 MW.

Injector for Nimrod

Vickers-Armstrongs (Aircraft) Limited have a nuclear section, and among their activities is the construction of the injector, shown in Fig. 1, for the 7 GeV proton synchrotron to be installed in the Rutherford Laboratory of the National Institute for Research in Nuclear Science at Harwell. The injector is a 15 MeV Alvarez proton accelerator. The vacuum envelope, inner liner and drift tubes have been designed jointly by Vickers and AERE, Harwell. The operating frequency of the linear accelerator is 110 Mc/s which gives rise to an inner diameter of 67·2in. To provide adequate stiffness when the liner rests on only two supports, the liner has been designed as inverted aircraft fuselage.

Fig. 1 Proton linear accelerator as used in the injector which Vickers-Armstrongs (Aircraft) Limited are building for Nimrod.

1. Drift tube mounting
2. Wall of r.f. liner
3. Flexible copper conductor from liner to drift tube
4. Copper r.f. conductor tube
5. Steel support tube.
6. Radio frequency liner. ½ in h.c. copper shell
7. Support stems and r.f. connections
8. Drift tubes of increasing length.
9. Proton input.
10. Endplate cooling tubes
11. Flight tube to synchrotron
12. Access hatch
13. Roller mounting
14. Support points
15. Manually adjusted flatteners.
16. Pumping slots
17. Cooling tubes
18. Main frames and liner supports
19. Vacuum vessel
20. Copper shell cooling tubes
21. Support and vacuum pumping tube
22. Copper r.f. conductor tube
23. Copper shell (r.f. conductor)
24. Copper r.f. conductor tube
25. Cooled magnet conductor tubes.
26. Steel support tube
27. Magnet coils
28. Magnet yoke



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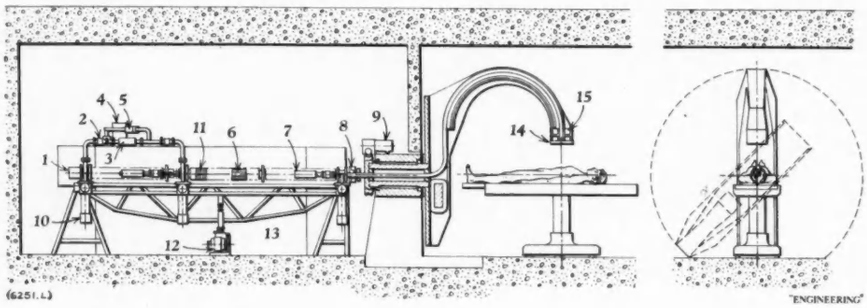
West Germany Orders 40 MeV Accelerator

The Metropolitan-Vickers Electrical Company Limited has secured an order for a 40 million electron-volt electron linear accelerator from the City of Hamburg for Deutsches Elektronen-Synchrotron (DESY), Research Group, Hamburg. The value of this order is approximately £250,000. The accelerator will be used to inject a beam of 40 MeV electrons into a large electron synchrotron which will then further accelerate the electrons to an energy of 6 GeV. To make this further acceleration possible, very rigorous restrictions are necessary on the output of the linear accelerator used for injection. Thus, very little variation is permissible on the specified 40 MeV energy, and the electron beam must be compact, that is small in diameter, and must have very little divergence.

The linear accelerator, which is of the travelling wave type, will be energised by short wavelength radio frequency power, and the electrons will be accelerated along a specially shaped waveguide. The equipment has an overall length of approximately 35 ft, and comprises five sections of accelerating waveguide, each 1½ metres long, together with an electron gun and pre-buncher at the injector end. Each accelerator section will be fed by a high power klystron, also made by Metropolitan-Vickers. In addition, a considerable amount of associated equipment including the klystron power supply together with controls and other services is included in the contract. The output of the accelerator at 40 MeV is in the form of short pulses of current of 2 microseconds duration, repeated 50 times per second. Each pulse of current must supply 125 milliamps within the strict limits of energy and beam geometry imposed by the acceptance requirements of the synchrotron.

Fig. 2 A 35 MeV linear accelerator for medical use designed by Vickers Research Limited.

1. Electronic gun
2. Waveguide window
3. Phase shifter
4. Klystron
5. Power monitor
6. Three 1 metre lengths of waveguide with stainless-steel water jacket
7. Radiofrequency load
8. Rotary vacuum seal
9. Motor and gear box
10. Diffusion pump.
11. Low impedance coils wound over water jacket
12. Rotary vacuum pump
13. Modulator.
14. Dectector for servo centering.
15. Scanning coils



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Medical Accelerator

Energies in the range 10 to 35 MeV are of interest in electron therapy; above 35 MeV the long tail on the ionisation-depth curve, due to the production of X-rays in the tissue, tends to nullify the therapeutic advantages to be gained from the use of electrons. The accelerator shown in Fig. 2 is made by Vickers Research Limited and gives energies in the range 10 to 35 MeV; it is powered by a single 20 MW klystron.

Tandem Accelerator for CalTech

A 10 MeV Tandem Van de Graaff accelerator for basic physics research has been purchased from High Voltage Engineering Corporation by California Institute of Technology under a contract from the Office of Naval Research. The million-dollar machine, fourth of its kind in the world, will be installed in 1960 at the Kellogg Radiation Laboratory of CalTech. Programmes utilising the accelerator will be under direction of Dr. C. C. Lauritsen, senior scientists. The Tandem, developed by High Voltage to meet requests for a machine to enable explorations of the nuclear energy level of certain heavy elements, is said to feature extreme beam homogeneity and stability in the 10 MeV energy range. The 35 ton machine comprises two 6 MeV Van de Graaff accelerators horizontally placed end to end with a common high voltage terminal. First machine of this type is now being installed at the Chalk River Facility of Atomic Energy of Canada Limited. Second and third machines

respectively will go to the University of Wisconsin and Florida State University.

Tandem Accelerators Exported

Two 10 MeV tandem particle accelerators have been sold to Switzerland and Australia—the first to be exported—by High Voltage Engineering Corporation. The million-dollar Van de Graaff machines now under construction are both scheduled for delivery in 1960. One of the machines, consigned to the Swiss Federal Institute of Technology at Zürich, will be installed at the "Kernphysik I" laboratory, about four miles from downtown Zurich. The huge positive-ion accelerator will be used for basic nuclear research in reactions produced by charged particles and fast neutrons. The other 10 MeV machine will go to the Australian National University at Canberra and will be used in experiments with hydrogen and deuterium bombardment of light and heavy elements.

Processing Accelerator

Vickers Research Limited also make linear accelerators for processing materials and for radiation therapy. The processing accelerator (or irradiation machine) shown in Fig. 3 is mounted vertically and employs 2 metres of accelerating tube powered by a 6 MW 10 kW average power klystron. The electron energy is 10 MeV and the average power 5 kW. Beam scanning and monitoring facilities are provided.

Equipment Costs at AWRE

The costs of the accelerators and associated equipment now installed at AWRE can only be given roughly, since parts of the design and construction were carried out by the UKAEA. The 12 MeV tandem accelerator was said to cost some £200,000 though an adequate allowance for design costs may not be included. The 6 MeV machine was purchased from High Voltage Engineering Corporation for about $400,000. The cost of the multichannel spectrograph has been given as roughly £25,000.

Accelerator Schedule

To justify the capital cost of a high energy accelerator, its utilisation must be high and the operational and scheduled maintenance periods must be chosen so that interruption of experimental time for unscheduled maintenance is minimised. The operating schedule envisaged is 120 hours experimental time followed by 48 hours maintenance. With a 2,000 hour klystron life, the average failure rate during a 120 hour period is 12 klystrons and even if on occasion the actual failure should be three times the average value, the operation of the accelerator will not be seriously affected.

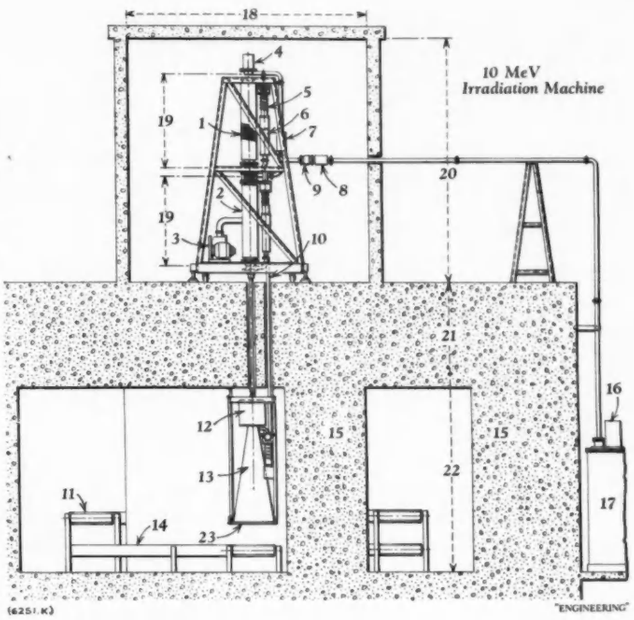


Fig. 3 Irradiation accelerator developed by Vickers Research Limited.

1. Low impedance coils wound over water jacket
2. Waveguide with stainless-steel water jacket
3. Rotary vacuum pump
4. Electron gun
5. Vacuum pump
6. Radiofrequency load
7. Phase shifter
8. Power monitor
9. Wavegude window
10. Backing pump manifold
11. Outward bound conveyor
12. Scanning coils
13. Scanning horn
14. Inward bound conveyor
15. Shield
16. Klystron
17. Modulator
18. Dimension: 275 cm square (9 ft)
19. Dimension: 1 metre
20. Dimension: 275 cm (9 ft)
21. Dimension: 120 cm (4 ft)
22. Dimension: 210 cm. (6·9 ft)
23. Electron window

Model Tests of 7 GeV Magnet

Tests have been performed on a 2/7 scale model of five sectors of the 7 GeV proton synchrotron magnet for Nimrod to determine its general magnetic characteristics under d.c. and pulsed excitation. The model follows the prototype in every respect except that the magnet sections are assembled parallel instead of along a circular arc. The tests helped to explain unusually high eddy current losses observed in a previously tested model of the magnet. The high losses are now attributed to faulty insulation between the pole-pieces and the yoke. The tests confirmed the original estimates of magnet current, but indicate that the power supply voltage estimate was about 2·5 per cent low. (Report A/R: The 7 GeV Proton Synchrotron Magnet, General Characteristics of Model AC 3, by D. A. Gray, A. H. Spurway and J. J. Wilkins, price 3*s*.)

Time Reversal Invariance

Physicists of the Argonne National Laboratory and the University of Chicago have shown that fundamental interactions between sub-atomic particles are unchanged under reversal of time. The principle involved is called time reversal invariance. It means if all motions of particles were reversed at the same time, they would proceed, following the same laws as before, to retrace their previous paths in the reverse direction. It has been demonstrated that time reversal invariance is valid in the decay of free neutrons, and thus by implication in all gasic physical processes.

Successor to the Bubble Chamber

A device known as a luminescent chamber has been developed at the University of Michigan whereby the light emitted along the trail of an electron passing through a scintillating crystal can be photographed. Expected to be as important in the study of high energy nuclear physics as the cloud and bubble chambers (AR, 1 June '56), the luminescent chamber may also be used to photograph light from the paths of mesons, protons and any other nuclear particles. To photograph the flash, which lasts about a millionth of a second, light amplification by a factor of 10,000 is required, and this intensification is achieved by a series of electron "image tubes," which in turn intensify the light and then focus it on the next tube by lenses; the tubes are made by Westinghouse and RCA. Primitive photographs of particle tracks in a luminescent chamber were published by the Russians four years ago.

Remote Reactors

Fuelled for Life

The de Havilland Engine Company's nuclear engineers have some interesting ideas. They believe that it is feasible to design high-temperature gas-cooled reactor plants for remote sites that will not need refuelling during their 20-year lifetime, and at the same time will not require an intimately associated chemical plant. In connection with this proposal, they take as reactor operating life three times the life at full power, allowing for inevitable periods of low power operation in an isolated system.

Reactor Replacement Service

Nuclear power stations of an earlier generation, which will require occasional refuelling (perhaps every six years), present problems of maintenance when installed in remote areas. De Havilland's are considering the possibility of mounting small reactors on railway vehicles to overcome this difficulty. For shielding they would be driven into tunnels at the chosen sites. When due for refuelling, a reactor would be hauled away to a central processing station, and another connected in its place, so eliminating the need for any power cut. Reactor shuffling would thus replace fuel shuffling. The reactors could be serviced at the makers' depot, and economies would follow from the use of centralised facilities serving many different plants.

References to Particle Accelerators

Previous references to particle accelerators and particle physics in ENGINEERING are listed below. Thermonuclear references were listed in Atomic Review on 8 May '59.

Articles.—156 in Synchrocyclotron at Liverpool University vol. 181 '56 p. 211; Acceleration of Nuclear Particles in Curved Paths: Cyclotron, Synchrocyclotron and Synchrotron (J. B. Adams) vol. 180 '55 p. 540; Linear Acceleration of Charged Particles (C. W. Miller) vol. 180 '55 pp. 340 and 374; Linear Accelerator 15 MeV at St. Bartholomew's Hospital and Cyclotron 45 in at Hammersmith Hospital vol. 179 '55 pp. 646 and 803; Othotron and Betatron for Radiotherapy at Manchester vol. 178 '54 p. 700; 31 MeV Betatron Installation at Zürich vol. 173 '52 p. 412; 16 MeV Betatron at the Clarendon Laboratory vol. 167 '49 p. 55.

Atomic Review. High energy accelerators, Subatomic particles, 9 Oct. '59; Xi-zero particle, Hydrogen bubble chambers 20 March '59; Proton beam in brain surgery 6 March '59; Pulsed neutron generator 30 Jan. '59; CERN budget, Vickers-Armstrongs (Aircraft) accelerator components, Niels Bohr on the atomic nucleus 19 Dec. '58; Power for NIRNS proton synchrotron 5 Dec. '58; Diffusion pump (Metrovick) for large vacuum systems, Cerenkov effect 7 Nov. '58; Proceedings of CERN conference 17 Oct. '58; Crucial particle experiment, Fundamental research, Fundamental nuclear physics course 26 Sept. '58; British, American, Soviet and French fundamental research, CERN, Joint Nuclear Research Institute 29 Aug. '58; CERN year and income 22 Aug. '58; 29 MeV Microtron 15 Aug. '58; Vacuum tank for 7 GeV proton synchrotron 20 June '58; Metrovick 4 MeV linear accelerator for irradiation service 13 June '58; Theoretical physics (A. Ashmore) 23 May '58; Vacuum system for proton linear accelerators 18 April '58; Conference on high energy nuclear physics, Cyclotron for Colorado 4 April '58; Vacuum pumps 28 March '58; Heisenberg equation 14 March '58; Unified field theory 7 March '58; Soviet strong focusing 50 GeV accelerator 28 Feb. '58; Linear accelerator (4 MeV) for petroleum company 7 Feb. '58; CERN president and accelerators, Conference on high energy physics 17 Jan. '58; Proton synchrotron building at NIRNS, Argonne proton synchrotron, Soviet proton synchrotron 10 Jan. '58; High energy accelerators (T. G. Pickavance) 3 Jan. '58; Contract for Rutherford Laboratory 27 Dec. '57; Soviet nuclear research, Nuclear matter fluctuation, Mesonium and antimesonium, Scattering matrix for two-nuclear system, Cambridge electron accelerator, Strangeness, Spiral ridge synchrotrons, First director of Rutherford Laboratory 13 Dec. '57; Joint Nuclear Research Institute at Dubna, Soviet 10 GeV proton synchrotron and 50 GeV machine 22 Nov. '57; Prize for Niels Bohr 8 Nov. '57; Tandem accelerator for AERE and AWRE, Wisconsin tandem generator, Steel economy in 7 GeV proton synchrotron 18 Oct. '57; Cambridge 6 GeV electron accelerator 27 Sept. '57; CERN projects, 25 GeV proton synchrotron and Linac, Acceleration by pinch effect, Metrovick work for CERN 30 Aug. '57; Neutron detection and mesonic atoms, Argonne 12 GeV proton synchrotron 23 Aug. '57; National Institute for Research in Nuclear Science, Cosmic particle 16 Aug. '57; Saclay accelerators 9 Aug. '57; Electron radiation facility 26 July '57; Scandinavian nuclear physics cooperation 28 June '57; Alternating gradient synchrotron, 1,000 GeV, Double synchrotron, Hilac (heavy ion accelerator), Soviet synchrotron, 3 GeV synchrotron, California synchrotron output increased, Linear accelerators, Making Van de Graaff machines, Neutrons from linear accelerator 3 May '57; Parity, Anti-nucleons, Quantum mechanics, Binding forces, Types of accelerator, Harwell accelerator projects, Australian 4 MeV linear accelerator, Electromagnets for accelerators 26 April '57; AWRE 6 MeV Van de Graaff electrostatic generator 15 March '57; Lecture on work of CERN, National Institute for Research in Nuclear Science 22 Feb. '57; Acceleration of ions for rocket propulsion 15 Feb. '57; Mesonic atoms 11 Jan. '57; Picture of the proton, British physics centre with accelerator 11 Jan. '57; 2 MeV Van de Graaff machine for Japan, Beam bending magnets and spectrometry 4 Jan. '57; Vacuum tank (Metrovick) for CERN 50 MeV proton linear accelerator, Symposium on high energy accelerators and pion physics 30 Nov. '56; Plan of CERN site 12 Oct. '56; Liquid gases in nuclear physics, Nuclear cooling 5 Oct. '56; Anti-neutron discovered 28 Sept. '56; Ford grant for CERN, Energy loss and range of electrons and positrons 31 Aug. '56; UKAEA and CERN accelerators 10 Aug. '56; Antiproton and neutrino 27 June '56; CERN symposium and world accelerators 22 June '56; Cambridge electron accelerator, Brookhaven proton synchrotron, Birmingham University proton synchrotron, Bubble chamber 1 June '56; Harwell 25 MeV electron linear accelerator 27 April '56.

New Cars Put Emphasis on Road Holding

New cars introduced in recent months show that good road holding embraces every item from the car structure right through to the tyre tread. There is a good measure of agreement between different manufacturers on the right steps to be adopted.

By Gordon Wilkins

The search for structural rigidity (combined with the need to reduce production costs and simplify assembly operations) has at last produced a major swing to the use of unit structures in the United States. The Chrysler group are using them on practically all models including the new Valiant, with 2·8 litre six-cylinder engine. Ford and Chevrolet are also using unit structures for their new compact models. One consequence is the abandonment of the exaggerated wrap-round windscreen with sharply cranked pillars. Chrysler now use stiffer curved pillars, but the door shut face in the panelling is designed to preserve the visual effect of a cranked pillar.

The outstanding exception is the Triumph Herald. Here domestic factory considerations dictated the decision to plan a range of vehicles—coupé, convertible, saloon and station wagon—with the maximum number of common panels, which could be brought out and assembled on the spot. A single common chassis frame, with body panels bolted together provided the answer and produced important consumer advantages in ease of repair.

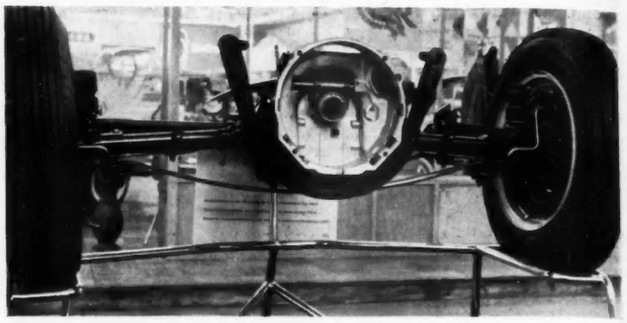
The use of separate subframes carrying suspension and engine mountings has been developed in order to reduce the transmission of high frequency road-excited vibrations from the road gear into the main structure, with consequent boom on rough roads, but the solutions adopted have sometimes had an adverse effect on road holding by introducing vagueness into the steering. Mercedes Benz, after some not entirely happy experience with a *fahrschemel* attached to the main structure by three soft rubber mountings, have adopted an entirely different and much more successful solution on the latest 220. The front subframe is attached by two large conical rubber mountings which are quite flexible vertically, but stiff radially. Fore and aft movement is restrained by two horizontal spring steel blades. In general it seems desirable to keep the mass of the subframe as low as possible. Some of the larger ones are associated with very unsatisfactory road holding. On the BMC baby car, both front and rear suspension units are mounted on subframes, the front frame also carrying the engine and transmission. They are attached to the main frame by eight rubber-bushed mountings with vertical and horizontal axes. This is a convenient method of assembly during manufacture, but there is very little flexibility in the mountings; the rubber suspension units themselves form an effective barrier against the transmission of vibration to the body.

In some cases of course the subframe and its mountings may be suspected for defects in road holding and steering which have their origins elsewhere. One manufacturer of a car with a front subframe which has suffered a good deal from steering vagueness, particularly at high speeds, has discovered that much of the blame lies with excessive friction in the kingpin pivots. In view of the modern tendency to eliminate greasing points, this is a problem which may be solved by the use of lubricant-free bushes or ball joints such as the sintered bronze bearings impregnated with a mixture of polyfluorethylene and lead, made by Glacier, which have no "stick-slip" effect. Such materials are already in use on commercial vehicles, but their adoption on passenger cars has been restrained by cost considerations.

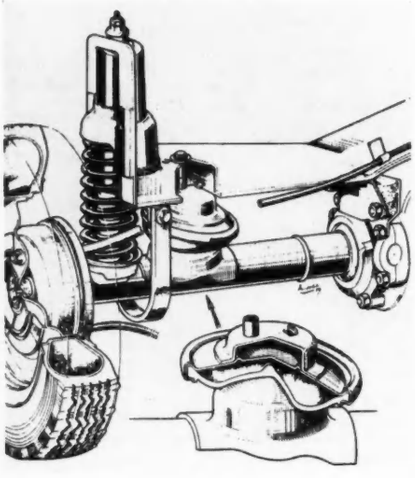
On their 220 saloon, Mercedes-Benz have sought improved road holding by raising the front roll centre and by reducing the roll stiffness of the swing axle suspension used at the rear. The higher roll centre was obtained by re-arrangement of the wishbones and their pivots. A minor defect in behaviour on this car is a tendency to nose dive during heavy braking which curtails the range of the headlamps. One cure would have been to use an anti-dive suspension with ball joint steering pivots and wishbone pivot lines so arranged that movement towards bump produces an increase in castor angle, which is resisted by brake torque, but as the existing tooling had to be employed for front suspension it could not be introduced at this stage. They have, however, reduced the stresses in the telescopic dampers by moving them as close as possible to the wheels, abandoning the convenient position inside the coil spring.

The single-pivot swing axle suspension was given a transverse coil spring compensator similar to that employed on the 300 SL sports car. A variation of this method is seen on some Porsche models for 1960, where a single-blade transverse leaf spring links the ends of the two-swing axles.

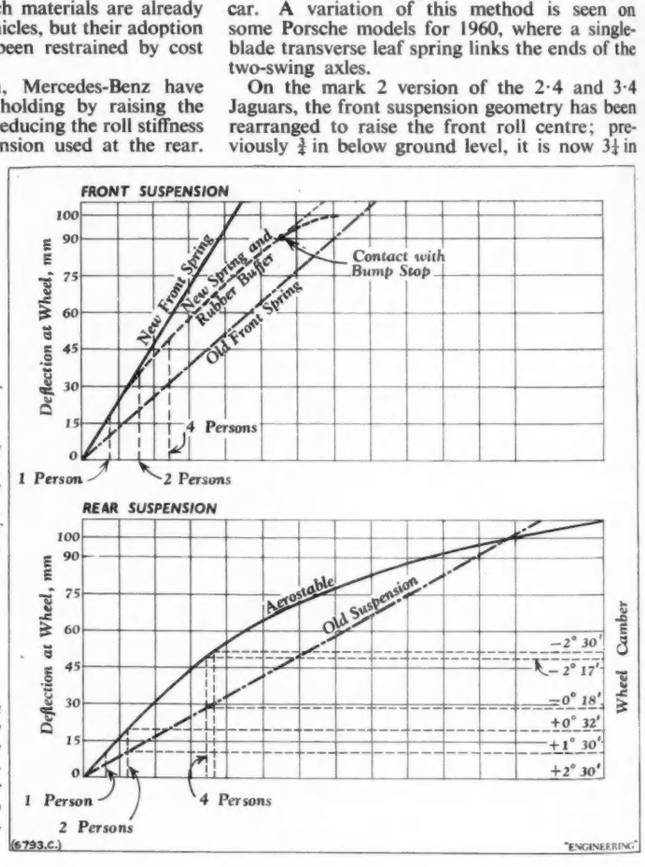
On the mark 2 version of the 2·4 and 3·4 Jaguars, the front suspension geometry has been rearranged to raise the front roll centre; previously ¾ in below ground level, it is now 3¼ in



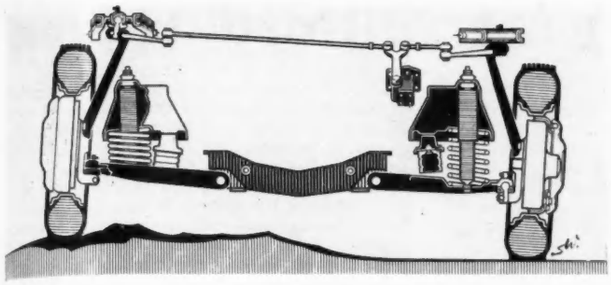
Transverse compensation spring on Porsche rear suspension.



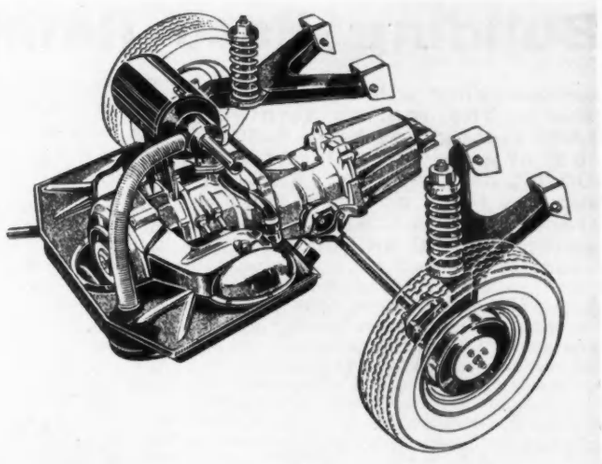
(Left) This drawing of the Renault "Aerostable" suspension shows the pneumatic cushion and buffer on the rear axle assembly. The coil springs, which are retained, are softer and of greater flexibility than on the old suspension.



(Right) Load-deflection curves for old and new rear suspension on the Renault Dauphine. Variations in wheel camber are also shown, with two persons and four persons on board.



(*Above*) *Front suspension on the Goggomobil Isar 700 small car. Ball-joint steering pivots are used and the upper wishbones are pivoted transversely on the scuttle bulkhead, an arrangement which gives an anti-dive effect under braking and can simplify the structure on a small, light car.*



(*Right*) *A low roll centre is obtained on the rear suspension of the BMW 700 by using trailing wishbones and drive shafts with two universal joints.*

above. The lower section of the yoke piece carrying the stub axle has been extended, giving a lower location for the bottom ball joint steering pivot, and the angle between kingpin axis and wheel has been reduced from 7½ to 4¼° by moving the top suspension ball outwards approximately ½ in. At the same time, rear track has been widened by 3¼ in.

The four-wheel independent suspension on the Triumph Herald looks deceptively simple, with conventional front end and swing axles at the rear with light longitudinal arms. No special measures have been taken to minimise camber changes at the rear, but road holding is remarkably satisfactory. One feature, however, is an unusually strong anti-roll bar at the front.

An outstanding combination of road holding and ride is obtained on the BMC baby car by independent suspension of all four wheels using the new progressive-rate Moulton rubber suspension units, combined with 10 in wheels to reduce unsprung weight. The suspension units employ rubber in compression and shear and are connected to the wheels by levers giving a 5:1 mechanical advantage. At the front the suspension linkage is reminiscent of that on the Morris Minor. At the rear, single trailing arms give a very low roll centre.

On the Volkswagen, road holding has been improved by the addition of an anti-roll bar at the front, and by redesign of the mountings for the rear engine-transmission unit which is now tilted forward slightly to lower the differential centre line by ½ in. This gives the rear wheels negative camber over a greater part of the working range and should postpone the transition to positive camber on rebound, which is accompanied by a sudden reduction in cornering power.

Renault have taken more elaborate measures with the same general objective on the Dauphine. Front and rear coil springs are more flexible, but are supplemented by rubber cones and air cushions respectively. At the front, hollow cones surround the lower ends of the dampers, presenting a rising resistance to bump movement. At the rear, rubber air cushions interposed between frame and swing axles give a progressively rising rate to the suspension. Previously the car gave good ride and road holding fully laden, but the ride was harsher and it was more tricky to handle on corners with driver only. Static deflection with driver only is now increased by about 10 mm at front and about 5 mm at rear, giving a ride equivalent to that obtained with the old cars with two up. Here also, the working range is moved further into the area of negative wheel camber, but the progressive rate should ensure that the ground clearance does not become inadequate when heavy bumps are encountered.

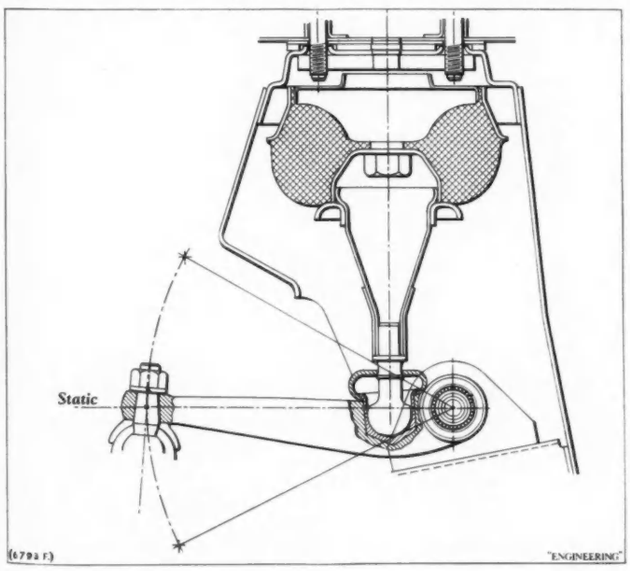
Faced with the task of producing technical arguments in favour of the new rear-engined Chevrolet Corvair, without appearing to damn the group's front-engined cars, Maurice Olley of General Motors dwelt upon the symmetrical distribution of disposable load which produces consistent handling characteristics, full or empty, on the rear-engined car. In either case, the weight distribution should be about 40 per cent front and 60 per cent rear. On a full-sized conventional American car, weighing 4,000 lb, unladen weight distribution would be about 55 : 45, changing to 50 : 50 with 800 lb of passengers and luggage on board. But on a 2,000 lb " compact " car, the same load would change weight distribution to 45 : 55. Apart from the effect on handling, this large variation in loading entails a harsh ride when lightly laden if conventional springs are used.

Good handling has been obtained with a 40:60 weight distribution on the rear-engined car, partly by using specially made " long cord " tyres on wide rims, the cords of the carcase being laid at an angle of about 30° to the wheel axis. Mr. Olley argued that rear-engined cars are often sensitive to side winds because of incorrect design. He said " The rear tyres are overloaded to begin with and then designers try to restore ' feel ' to the steering by excessive castor angles, or even by putting centering springs on the steering."

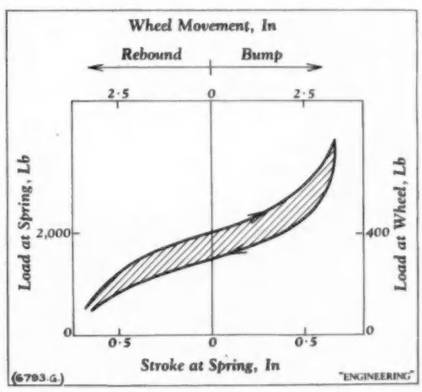
The rear suspension used on the Corvair is a modified swing axle in which the hubs are carried on single wishbones pivoted at about 45° to the car's longitudinal axis, so that bump movement produces toe-in and tends to diminish oversteer. The suspension medium is a coiled spring with concentric telescopic damper.

Mr. Olley also made the point that, having designed for correct handling with a 40 : 60 weight distribution, one has the associated advantages of light steering and an increase of 30 per cent in the maximum acceleration possible without wheelspin.

The new Falcon, Ford's " compact " car presumably suffers from the defects mentioned by Mr. Olley, as its suspension is entirely conventional, except that the front suspension coil spring is interposed between the upper wishbone and an abutment in the wheel arch, as on Nash cars. Rear suspension is by asymmetrical leaf springs, tilted forward to eliminate roll oversteer.



(*Left*) *Moulton suspension unit on BMC baby car. The rubber works in compression and shear, and the unit is connected to the road wheels by a 5 : 1 leverage.*



(*Right*) *Load-deflection curve for the Moulton suspension unit, showing the hysteresis characteristic which has permitted the use of lightly stressed orifice control dampers.*

Building Esso Refinery at Milford Haven

Landscaping will hide the refinery. The marine terminal, 3,500 ft long, has been built in 80 ft of water. It will cater for 100,000 dwt tankers. Air cooling has been adopted for the process units. The furnace generates 500 million Btu per hour.

The oil refinery at Milford Haven for Esso Petroleum has reached the half-way stage of construction. Work at the site began a year ago and the refinery is scheduled to come on stream in October, 1960. The cost of the project is £18 million. Of the equipment to be installed, 98 per cent is British made.

Exceptional care is being taken to minimise the impact of the buildings and plant on the landscape. The site is such that most of the refinery is being built in a natural ravine and the number of points from which it can be overlooked from the ground is very small. Advice is being sought from the Forestry Commission and, if it is likely to be practicable, screens of trees will be planted to hide the site completely. Altogether the petroleum company have taken over 1,100 acres, of which only 350 acres will be required for the tank farm and process units. The remainder will continue to be used for farming or be converted to a sports ground; and, even so, within the process area gardens and pools will be laid down to present the best possible appearance. The colours to be used for painting the tanks and units will also be chosen to harmonise with the natural surroundings.

Operation of the refinery is to be based on a conventional oil processing circuit. Middle East crudes will be brought in by sea and will be used to make propane, butane, petrols, turbojet fuels, diesel oil, gas oil and fuel oils generally. About 99 per cent of the refined products will be dispatched by coastal tanker. The capacity of the refinery will be 4½ million tons per annum or 100,000 barrels per stream day. It will operate with a staff of 450, of whom 50 will be brought into the area by the company and the remainder will be local people who will be taken on and trained as the refinery is commissioned. The maximum number being employed at the site during construction is 2,300 and that peak figure is being reached now.

Grading of the site is now complete, except for the finishing touches such as trimming that can best wait until the construction blocks are complete. Altogether, 1 million tons of spoil have been shifted by the contractors, George Wimpey. The refinery road network is 7½ miles long and the base course is complete—the skimmed silt stone of the area is a good natural foundation for a road; as the completion date approaches a top asphalt finish will be laid. The silt stone also formed a good base for the process units and no deep foundations have been required. Work on sewers, drains, fire mains and the piping installation between units is finished. The fire fighting system is independent of other water supplies and will use sea water. Drainage ditches have been made by shaping the channel and gunniting the sides and invert.

Storage tanks are a large item of a modern refinery and there are 68 at Milford Haven. In addition there are four butane and propane spheres and other storage drums. Of the 68, 40 of the tanks, those that are for " light " products, have floating roofs which minimise evaporation and thereby reduce air pollution—which, like landscaping, is another aspect of preserving the amenities. The situation of the site, with considerable natural crossfalls and a hard formation, has made it possible to dispense with bunds and fire walls around the crude oil tanks. In the event of a leak, the spilt oil will flow through the drainage system to a skimming pool that has been formed by putting a dam across the sea end of the ravine.

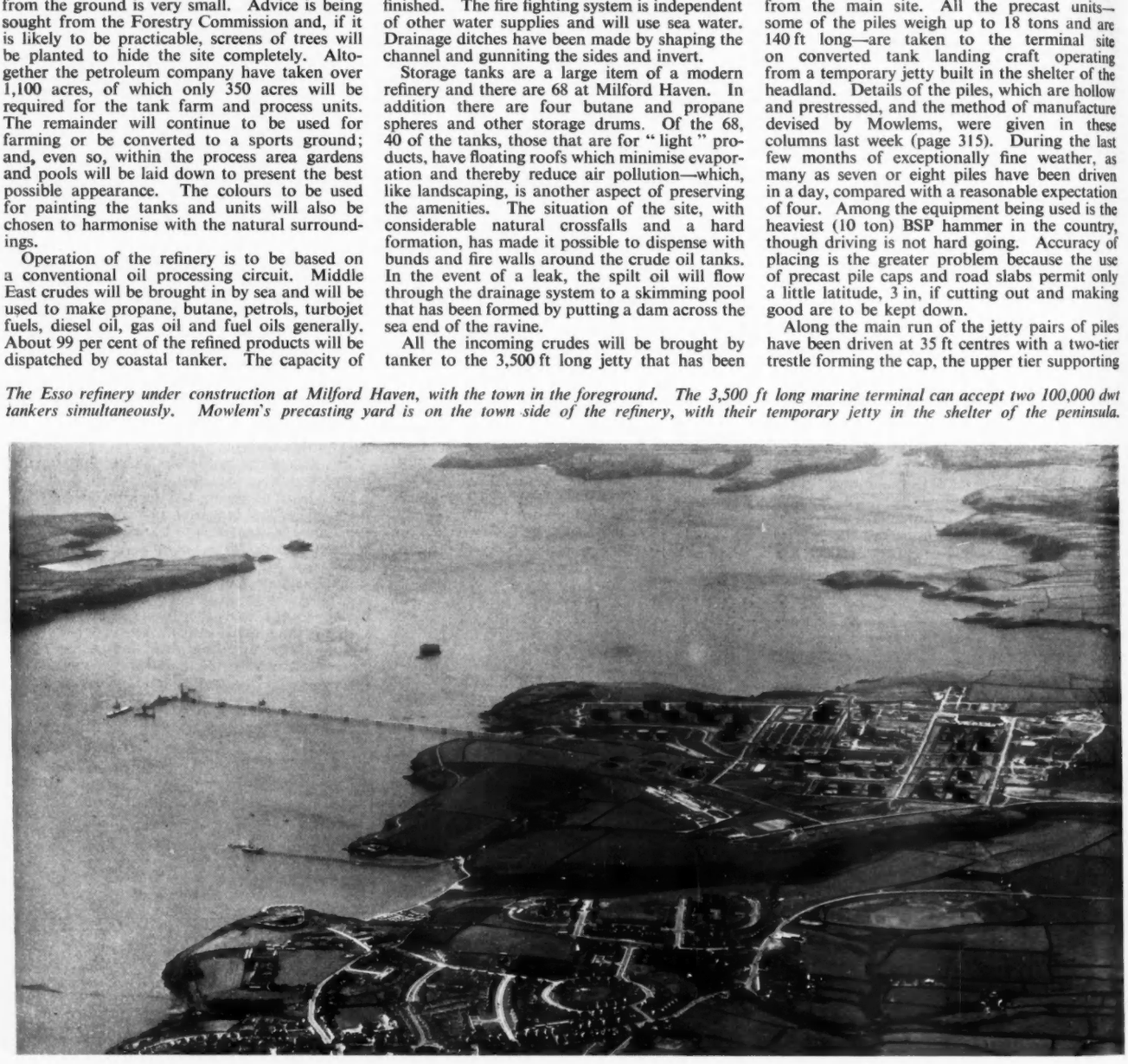
All the incoming crudes will be brought by tanker to the 3,500 ft long jetty that has been built in the Haven. The jetty has a T plan and is headed by two outside berths that will take 100,000 dwt tankers at all states of the tide, though there can as yet be no forecast of when such supertankers will be coming to Milford Haven. It is probable, however, that within a short while of the refinery being commissioned, 70,000 ton tankers will be using the terminal regularly. An inside berth will take coastal tankers of up to 5,000 dwt in which the finished products will be dispatched.

Esso Research and Engineering Company prepared an outline specification for the jetty and invited tenders from selected contractors who were permitted to incorporate their own details and devise the method of construction. The contract was awarded to John Mowlem. Strong Atlantic tides and 80 ft of water at high tide did nothing to ease the problems of design and construction.

The jetty is built of precast concrete members which, including the 915 piles, have been made in a casting yard laid down a short distance from the main site. All the precast units—some of the piles weigh up to 18 tons and are 140 ft long—are taken to the terminal site on converted tank landing craft operating from a temporary jetty built in the shelter of the headland. Details of the piles, which are hollow and prestressed, and the method of manufacture devised by Mowlems, were given in these columns last week (page 315). During the last few months of exceptionally fine weather, as many as seven or eight piles have been driven in a day, compared with a reasonable expectation of four. Among the equipment being used is the heaviest (10 ton) BSP hammer in the country, though driving is not hard going. Accuracy of placing is the greater problem because the use of precast pile caps and road slabs permit only a little latitude, 3 in, if cutting out and making good are to be kept down.

Along the main run of the jetty pairs of piles have been driven at 35 ft centres with a two-tier trestle forming the cap, the upper tier supporting

The Esso refinery under construction at Milford Haven, with the town in the foreground. The 3,500 ft long marine terminal can accept two 100,000 dwt tankers simultaneously. Mowlem's precasting yard is on the town side of the refinery, with their temporary jetty in the shelter of the peninsula.



the road slabs and the lower carrying the pipe run, which has a total bandwidth of 45 ft. The piles, except those at the head of the jetty, are held at the toe by driving them through the 40 ft of clay until they bear on the silt stone. At the head of the jetty the clay is only 15 ft thick, insufficient to give good toe fixing of the piles, and in this area the piles have been fitted with steel shoes and driven into the harder formation.

At intervals of 315 ft along the jetty, strong points have been created by putting down groups of piles, including raking (1 in 3) piles. These strong points will resist movements that might otherwise be set up by the expansion and contraction of the pipe runs (the crude oil is pumped at 140° F). The roadway along the jetty is 16 ft wide made up of two 8 ft wide slabs, reinforced with mesh, that span the 35 ft between pile caps. Between the slabs the gap has been made good with *in situ* concrete reinforced with high tensile, steel and similarly reinforced kerbs have been built along the roadside. These long reinforced "stringers" have the dual function of carrying the live load and of tying the structure together into a monolith of great stability. At the strong points, and also for the dolphins beyond the head of the jetty, the pile groups have as a pile cap a solid block of *in situ* concrete that has been placed above permanent precast shuttering. Another feature of the jetty is the increase in height of the roadway above sea level along the inshore reaches to provide greater clearance for local vessels that move up the Haven in the protection of the cliffs.

Fendering for the main berths consists of 36 in by 12 in broad flange joists driven into the clay and with spring-loaded buffers between the joists and the pile caps to absorb the momentum. Greenheart and elm rubbing members are to be fitted. The worst condition that has been assumed in the design of the jetty is that produced when an empty 100,000 ton tanker is riding high at the jetty and subjected to a gale blowing side on.

With change of temperature and the passing of the oil the pipe runs are liable to considerable movements, amounting at some points to many inches. Where the pipes are supported they bear on steel rounds set in the head of the trestle concrete; movement of the pipes therefore occurs with steel-to-steel rubbing—a condition that experience has shown to be more economical than the provision of more complicated roller systems. Experience has also shown that simple square-link expansion loops are satisfactory; they are more economical in construction than Ω loops and a modern tanker is quite capable of pumping against the extra head losses at the right-angle bends. In the event of spillage from moored tankers, oil booms are to be provided that can quickly encompass the floating oil.

The refinery will operate on a conventional distillation and refining circuit. The single-stage atmospheric pipestill will be able to handle 100,000 barrels a day and has gas compression, stabilisation and naphtha-splitting facilities to produce the raw materials for the manufacture of the ultimate products—principally petrols, jet fuels, diesel and fuel oils. To do this the crude oil is heated to around 750° F and the furnace of the pipestill is the largest of its kind in the world, equalling a sister furnace at Rotterdam and producing nearly 500 million Btu per hour. The steelwork for the furnace is erected and the fire-bricks are partially complete; installation of the tubes is about to begin. Nearby, the 300 ft stack is built and the lining is more than half complete.

The six towers of the pipestill are in various stages of completion, except for one that has yet to be delivered. Also nearly complete are the 14 finned air coolers which will be "cocooned" as protection against the weather until the refinery is commissioned. They consist of tubes with aluminium fins through which the oil circulates, and cooling comes from air blown across the fins by electrically driven fans, 10 ft in diameter. Air cooling, though a high capital charge, has a much lower operating cost than water cooling and does away with the problems of handling large volumes of water effluent.

Two special units are the hydrofiner and powerformer. The former reduces the sulphur content of the naphthas and diesel oils and its main component, the catalytic reactor, is well advanced. The powerformer converts low-octane naphtha to high octane constituents for premium motor spirit. This unit is being delayed to take advantage of last-minute advances in design, and the foundations only have been prepared. Another plant in the early stages of construction is the copper chloride sweetening plant in which unpleasant smelling compounds in the lighter spirits are converted to make products with a pleasing odour. Apart from the boiler house there is only one process control room for the whole refinery. The shell of this building is complete but the graphic panel has yet to be installed though instrumentation around the site is proceeding.

The skimming pond is both a first and second line of defence against pollution. Into it goes all the surface drainage from the area as well as water that has previously been through the process unit separator. Any oil that reaches the pond will be removed by a skimmer and clean water will be pumped into the haven below the low water mark. The pond and skimming box are complete.

Unlike most refineries there will be no flare stack. To deal with any emergency release of gas that cannot be burned in the boilers or furnaces, a multi-jet ground flare, which is smokeless, noiseless and non-luminous, is being installed.

The design of the refinery is the work of the Esso Research and Engineering Company, and the main contractors for the process units are Foster Wheeler Limited. Apart from the civil engineering contractors, George Wimpey and John Mowlem, already mentioned, other principal contractors are Whessoe Limited, W. Neill and Son (St. Helens) Limited and the Motherwell Bridge and Engineering Company Limited.

Explaining BS 449: 1959

The new BS 449 for structural steelwork issued earlier this year has taken into account a number of factors not considered in the earlier standard; other factors, though dealt with previously, are now presented with substantially amended clauses. Such factors include the treatment of laterally unsupported beams and battened compression members; the stability of angles used as purlins, ties and struts; the strength of encased beams and columns; and the limiting stresses to be adopted.

The British Constructional Steelworks Association has now published *An Exploratory Brochure* by Mr. Lewis E. Kent, M.I.C.E., M.I.Struct.E., M.Cons.E. The brochure is principally for the use of the steelwork designer who, hitherto, has had to comply with the requirements of BS 449: 1948. To that end, all the differences between the two standards have been stated and worked design examples, illustrating these differences, are included. The brochure is available from the Association at 94-98 Petty France, London, SW1, price 3*s* 6*d*, post paid.

Long-life Protective Clothing for Tunnelling Gangs

A new Neoprene-coated protective clothing has been tried out for the gangs working in the tunnels being driven for the Kiewa hydroelectric project of the State Electricity Commission of Victoria, Australia. The cloth has a good tear strength, is abrasion and weather-proof, and has a good resistance to oil—which enables it to withstand the mixture of oil, air and water thrown back from the pneumatic drills at the working face. A far longer life is claimed for the Neoprene clothing than had been obtained before, especially as it can be effectively patched.

Good Jointing on Small Drains

A new Building Research Station digest, No.125, *Small Undergrond Drains and Sewers: II*, is concerned with flexible joints, site work, testing and watertightness of drains. (A previous digest, No. 124, part I of the same title, dealt with their structural design.)

Attention is drawn to the avoidance of conditions that lead to fracture of the pipes in the event of differential settlements. Such troubles can be eliminated by using flexible joints; providing ample clearance around a pipe that passes through a wall; avoiding hard and soft spots in the foundation, so ensuring uniform bedding of the pipe. Good site practices are also described. Copies of the digest can be obtained from HMSO price 4*d* each, postage extra; quantity rates are also quoted.

High Speed Shaft Sinking in South Africa

A new shaft sinking record is claimed by Vaal Reefs Exploration and Mining, a South African company, of 922 ft in 30 days while working on the Anglo-American Corporation's Vaal Reefs No. 2 shaft. An AEI twin-motor sinking winder, rated at 5,200 h.p., has been used and the mining team comprised 48 Europeans and 353 Africans, who worked four shifts a day. At the end of the 30 days the shaft had reached a depth of 2,054 ft; the ultimate depth will be 7,200 ft.

The previous best figure was attributed to the Russians, who, last April, lowered a shaft 868 ft in 30 days. In the Russian case, the shaft diameter was 21·5 ft; that of the Vaal Reefs No. 2 is 26 ft.

New Lecture Hall in London

Simultaneously with the reconstruction of Hyde Park Corner, the Royal Aeronautical Society are going ahead with their plans for a new lecture hall to seat 300 people. The contract for the extension has been let to Holland & Hannen and Cubitts Limited; the architects are Ley, Colbeck and Partners.

Details of the scheme, including a photograph of a cutaway model, were given in ENGINEERING for 22 May, 1959, page 671. As was pointed out then, access to the site for building purposes is only possible while general reconstruction continues in the area; this means that the completion date will have to be about October next year. When the plans were announced the Society appealed for funds; although considerable sums were given or covenanted, further donations are still required.

Natural Rubber Bridge Bearing Pads

A natural rubber bearing pad for bridges is now being marketed by PSC Equipment Limited, Arundel Road, Uxbridge, Middlesex, under the name of Freyssi bearing pads. The pads comprise rubber bonded between two thin sheets of steel to form a sandwich, the rubber taking up all the shear movement that is imposed on the bearing. To meet any load magnitude economically a range of pads of different areas is available; to accommodate lateral movement the pads are used one above the other until the required shear capacity is available.

Given protection from direct sunlight, such pads can provide a long life with no maintenance. They are particularly well suited for use on skew bridges, where there can be sideways as well as longitudinal components of the deck movements.

THE 1960 JAGUARS

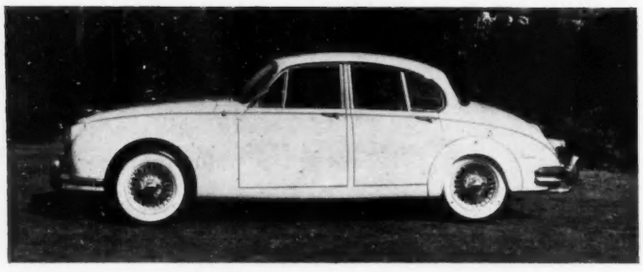
New 3·8 Saloon, Improved 2·4's and 3·4's More Power for XK 150

By Gordon Wilkins

For 1960 the 2·4-litre and 3·4-litre Jaguar saloons are offered in much modified Mark 2 versions and buyers who want still higher performance can now have a 3·8-litre engine in the same car with a limited-slip differential.

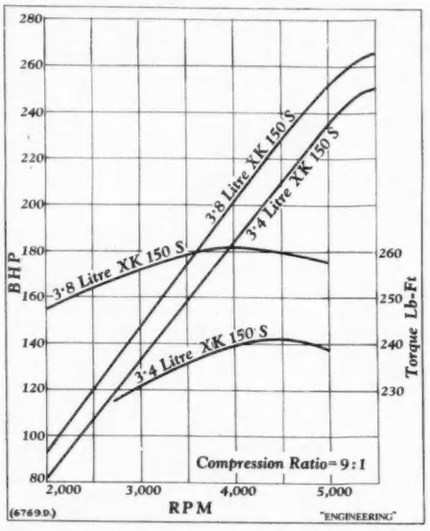
The XK 150 is now available with a 3·8-litre engine using three SU carburettors. It gives 265 b.h.p. at 5,500 r.p.m. (without fan and dynamo), making it the most powerful engine ever offered in a production model Jaguar.

The 2·4, 3·4 and 3·8 saloons have disc brakes on all four wheels and redesigned suspension. Rearrangement of front suspension geometry raises the front roll centre from $\frac{3}{4}$ in below ground level to $3\frac{1}{4}$ in above ground level. This was achieved by two changes. The lower section of the yoke piece which carries the stub axle has been extended, lowering the bottom ball joint steering pivot by $1\frac{11}{16}$ in. Secondly, the angle between kingpin axis and wheel has been reduced from $7\frac{1}{2}°$ to $4\frac{1}{4}°$, by moving the top suspension ball outwards approximately $\frac{1}{2}$ in, the upper wishbone pivot being repositioned accordingly. Basic design of the suspension remains unchanged, with semi-trailing wishbones, coil springs, telescopic shock absorbers, anti-roll bar and steering gearbox all mounted on a separate beam connected to the body-chassis unit via rubber mountings. Rear track has been increased by $3\frac{1}{4}$ in and the rear wings have been redesigned accordingly. As before, rear suspension is by long cantilever springs. The rear end of the spring is attached to the axle by a rubber bush, the centre is attached to the chassis by a flexible rubber sandwich and the front end rests on a rubber pad. The entire spring is thus insulated from the body structure to prevent transmission of road-excited noise.

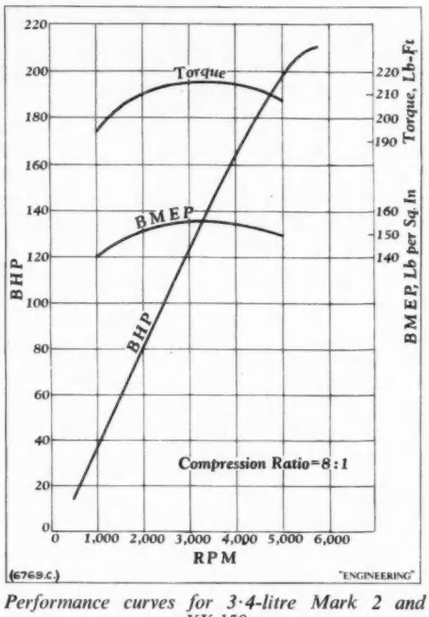


(*Right*) *Now available with a 3·8-litre engine, the XK 150 develops 265 b.h.p. at 5,500 r.p.m. (without fan and dynamo). Three SU carburettors are used.*

(*Above*) *Much improved visibility is the most noticeable improvement to the outside of the new Jaguar Mark 2 series.*



Comparison curves for 3·4 and 3·8-litre models of the XK 150.



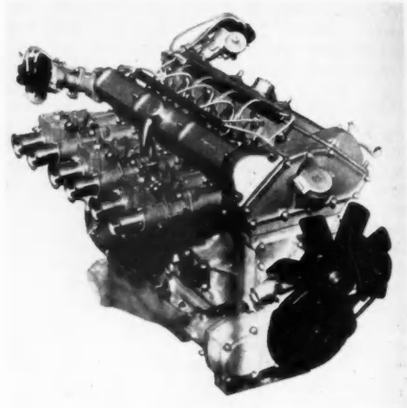
Performance curves for 3·4-litre Mark 2 and XK 150.

On Mark 2 2·4-litre cars, the "B" type cylinder head (previously available only on the 3·4 XK engine) raises the power from 112 to 120 b.h.p. at 5,750 r.p.m. Maximum torque is 144 lb-ft at 2,000 r.p.m. on the standard 8 : 1 compression (7 : 1 compression is optional). The 3·4-litre engine develops 210 b.h.p. at 5,500 r.p.m. with maximum torque of 215 lb-ft at 3,000 r.p.m. The 3·8-litre power unit develops 220 b.h.p. at 5,500 r.p.m. with maximum torque of 240 lb-ft at 3,000 r.p.m., equivalent to 157 lb per sq. in BMEP.

A new item of electrical equipment is a dual-purpose warning lamp which shows the driver if the level of brake fluid falls dangerously low and also warns him not to drive away with the handbrake on.

Basic outline of the car is unchanged but all-round vision is much improved. There is a larger windscreen with slimmer pillars, and a bigger rear window extending round into the rear quarters. Doors on Mark 2 cars are not fully panelled but have slim chromium plated window frames, and the rear door line has been modified to give a bold sweep to the window. Obstructions to vision have thus been cut considerably and glass area extended. There are now swivelling ventilation panes in both front and rear doors. The radiator grille is changed, fog lamps are now recessed into the front wings and the side lamps are mounted on top of the wings with red tell-tail lenses to warn of bulb failure. There are new door handles with push-buttons and new groupings of stop, tail, direction indicator and red reflectors at the rear.

Seats and interior finish and instrument panel are also redesigned. Speedometer and tachometer are grouped in front of the driver where they can be read through the new two-spoke steering wheel which carries a half horn ring.



A new heating system of 3·9 kW output (against 2·6 kW) takes fresh air from an intake at the base of the screen. Air goes through vents into the front compartment and through a duct on the centre tunnel to the rear compartment. Valuable features on a fast car are the combined direction indicator and headlamp flasher lever below the steering wheel and the electrically-operated windscreen washers. Access to the rear of the instrument panel for service operation has been made easier.

Transmission is by the usual four-speed gearbox with the option of Laycock de Normanville overdrive or by Borg Warner automatic transmission at extra cost. Incidentally, the automatic transmission is now ordered on 85 per cent of Mark IX cars.

Two variations of the 3·4-litre engine are offered on the XK 150 sports car, one with 8 : 1 compression and two SU carburettors giving 210 b.h.p. at 5,500 r.p.m. and another with the "B" type straight-port head with 9 : 1 compression and three SU carburettors developing 250 b.h.p. at 5,500 r.p.m. Now the 3·8-litre engine is also offered in two forms. With the "B" type head and two carburettors it develops 220 b.h.p. at 5,500 r.p.m. but with the "S" type head and three SU carburettors it develops 265 b.h.p. at 5,500 r.p.m.

HISTORIC CARS ON SAFARI

Lord and Lady Montagu of Beaulieu leave England this week for a four months tour of South and Central Africa with a collection of the most interesting exhibits from the Montagu Motor Museum at Beaulieu. The cars they are taking include Viscount Montgomery's Humber staff car "Old Faithful" which he used throughout his campaigns from the Nile to the Sangro, the 1920 350 h.p. Sunbeam in which Sir Malcolm Campbell twice broke the world speed record, a 1909 8 h.p. Humber and a 1903 De Dion Bouton. Other exhibits include King Edward VII's Humber tricycle and King George V's Humber bicycle.

Five Star Half Year

Most brilliant of the company figures to come out of the booming consumer market are Ford's half yearly results. On a 6½ per cent rise in sales values over 1958's first six months the company returns a 35 per cent leap in net profits, a sure indication of the benefits of the new production equipment at Dagenham.

1958 itself was no year for the company to complain of but it is left well behind with a £16 million rise (28 per cent) in the half year's trading profit. This is a trading profit of 13·8 per cent on turnover or £67 for every vehicle sold.

The public's favourable reception of the new models is well known but, looking ahead, the Dagenham chiefs see some increased costs from the building up of production and new plant being run in.

So successful a first half brought about the increase in the interim dividend, expected by the market, from 3½ per cent to 5 per cent.

BP Round Up

Few industries can match the petroleum industry in their public relations. They have grown accustomed to the need of putting to the public their case for making a profit out of a product of nature, often in the territories of under-developed nations, only too ready to claim that they are being exploited. The British Petroleum Company Limited's newsletter is an excellent example of the way petroleum companies keep in touch with their public at all levels.

The progress made by the company in the distribution of their products in Canada is described in the September issue of the news-letter. BP have acquired 16 service stations and a bulk plant from a large north-eastern Toronto distributor which raised the total number of their retail outlets in Canada to over 500. In the Montreal area their products are now being distributed by road and rail from a depot built at the company's new refinery at Ville d'Anjou, which is not yet complete. When commissioned, in the spring of next year, it will deal with a crude throughput of one million tons a year.

The BP products are at present obtained from a nearby refinery processing BP crude under contract. In New Zealand BP (New Zealand) Limited have commissioned a new permanent storage depot at Bluff on the southern tip of New Zealand's south island. This will be supplied mainly with products from BP's Kwinana refinery in Western Australia.

BP have led the way in the use of films both for public relations and sales promotion purposes, and many of these have been screened at film festivals all over the world. "Atlantic Crossing," for example, which was sponsored by BP as part of their contribution to the Commonwealth Trans-Antarctic expedition, has been shown at festivals in Vancouver, Moscow and Edinburgh. A cartoon, "The Energy Picture," made this year and first screened in April as part of BP's fiftieth anniversary celebrations, has also been shown at festivals in Moscow as well as Berlin, Edinburgh and Trinidad. "Three Roads to Tomorrow," a BP film which was shot in Nigeria, will be shown at the third African film festival, to be held in Somalia early next month.

Mechan's Recovery

The impact of improved management on a company's fortunes has rarely been so noticeable as in the case of Mechans Limited who were taken over in 1957 by Horseley Bridge and Thomas Piggott Limited. After a history of losses and shrinking trade Mechans earned profits of £9,691 during the six months that followed the acquisition and £89,485 during the subsequent 12 months (year ended 31 March, 1959). In his annual statement, the chairman of Horseley Bridge and Thomas Piggott, Mr. John V. Sheffield, said that "the extensive reorganisation and economies" which were undertaken after Mechans joined the group, coupled with a record production, proved that the company could earn very satisfactory profits.

The group as a whole, who are steel manufacturers and fabricators and constructional engineers, increased their profits before tax, by some £34,000 to £39,000 during the year under review, for the fourth year running. Despite this, Mr. Sheffield, who is chairman of several engineering companies including the Norcross group, said that he could see "very little sign of a substantial improvement in trading conditions in the immediate future."

Most of last year's profits were obtained from running down a very large order book and increased efficiency in their various works, but the deterioration in trade which began last year is continuing and will cause several department of the group, including Mechans, to work below capacity during the current year. Another depressing factor is the considerable price cutting which has taken place in the industry, "in some circumstances," said Mr. Sheffield, "to an uneconomic level."

Hillmans in Prague

An order for 500 of the latest Hillman Minx de Luxe saloons valued at £250,000 has been received from Czechoslovakia by the Rootes Group. They will be sold by Motokov, the import agency for vehicles, to private citizens "according to a priority list."

This is the first time an order for private cars from Czechoslovakia has been received by Rootes, and probably the only large car order to be placed in Britain by the "iron curtain" countries. It is a welcome sign of the increase in trade in consumer goods which the recent discussions in Moscow foreshadowed. The cars will be serviced by Mototechna, who have ordered £20,000 worth of spares, through a chain of service stations throughout the country. The Rootes Group mobile school is being sent to help train Mototechna mechanics.

Rootes have won more spectacular, if less unexpected, orders from the United States, including over £5 million worth of their new Alpine Sunbeam cars. Since 5 September, eighty of their main North American dealers and their wives were flown over to Britain "to see for themselves the manufacturing organisation behind the cars they are selling." They are ending their three weeks stay with a five-country Continental rally.

Small Company Finance

The problems of securing finance for those small companies who choose to remain independent is just as difficult as it was 10 years ago. The vast growth of groups, such as Norcross, Tillings, and many investment trusts, proves that the demand for financial support is considerable. The industrial activities of the banks are less easy to measure, although the total advances of the 11 clearing banks, which fell to £1,859 million in January 1958, rose to £2,456 million in March 1959. The business transacted by the Industrial and Commercial Finance Corporation (controlled by the big five) illustrates the need for a source of risk capital which does not entail the surrender of financial independence.

The ICFC's report for the 12 months ended 31 March 1959 indicates that their portfolio increased by £1·4 million to £35·7 million during the period, and that the outflow of cash and investments was £4·1 million. The amount of new business transacted, though small in relation to the need of industry, was substantially higher than the previous year (£5·02 million compared with £3·8 million) and nearly up to before-credit-squeeze level. The corporation's chairman, Lord Piercy, states that during the 12 months under review 313 applications were received from new customers and that offers were made to 63. At the end of March this year the corporation was actively engaged in supporting 655 companies.

Lord Piercy was able to announce that the corporation was now in a position to approach the money market for funds instead of relying wholly on its banking shareholders for the resources which it is able to employ. The shareholders have been paid the £15 million of share capital and the corporation will enter the market as soon as favourable conditions are present, with a long term debenture issue for a substantial amount. This suggests that ICFC will in future have more scope for determining its policy and a greater degree of help to small companies is likely to result. The fact that their lending activities were largely in competition with the banks was unsatisfactory and the new move towards greater freedom should therefore be welcomed.

Electrical Orders

The British electrical machinery industry continues to book large orders at a very satisfactory rate, despite setbacks in the United States where being the lowest bidder is less and less a guarantee of being awarded large contracts. The latest example of this is the rejection of a bid, by the English Electric Export and Trading Company, for four turbine generators for a dam project at Barkley, Kentucky. Their quotation was $68,000 (about £24,000) lower than that of the General Electric Company, who obtained the contract. The United States Government's action was defended by the comptroller general, Mr. Joseph Campbell, who said that in his view English Electric had no grounds for complaint because, according to United States army engineers, their bid was not up to specification. An English Electric spokesman, however, said that the reference to specification "might mean anything" and that he was "a little bit suspicious of it" because his company have been building generators and transformers for the United States for some considerable time.

Electrical companies who have recently won large contracts include the General Electric Company who were awarded a contract for five power transformers worth £330,000 for installation in this country by the Central Electricity Generating Board, three of them of 45 MVA, one of 60 MVA and one of 144 MVA. Ferranti Limited obtained an order worth $250,000 from the Anaconda Wire and Cable Company of Hastings-on-Hudson, New York, for what is believed to be the largest high-voltage alternating current cable testing set yet built by a British manufacturer. Included in the order is a 14 MVA 250,000 volts test set capable of supplying 55 amps for approximately two hours. A second transformer unit will, when connected in cascade, give an output of 500,000 volts at 6 amps continually.

The English Electric Company have to some extent made up for the loss of the American contract by obtaining one worth over half a million pounds for the supply of diesel generating equipment to the Karachi Electricity Supply Corporation. The order includes 11 diesel generating sets which will supply power to a total of 15,000 kW for the industrial area of Karachi. The engines are of the supercharged dual-fuel type which will run on natural gas piped from the large Sui gas field in West Pakistan. The engines are of the SRLD type operating at 428 r.p.m. and the alternators each have an output of 1,364 kW.

Effects of Unbalanced Wheels on Vehicles

Inherent or induced unbalance of wheels is common to all automobiles. At high speeds this lack of balance may cause resonances to occur in the suspension system, giving rise to discomfort, or even danger.

By P. Srinivasan, Assistant Professor in Mechanical Engineering, Indian Institute of Science

Some lack of balance, either inherent or induced, is usual in automobile wheels. It may be inherent owing to imperfect balancing or it may be induced by the uneven wearing of the tyres. This lack of balance sets up a centrifugal force in the plane of the wheel when the vehicle is in motion. The frequency of the force depends on the forward speed of the vehicle, and when it coincides with the natural frequency of vibration of the wheels the well-known phenomenon of "resonance" occurs. So long as the driving speeds of automobiles were below those corresponding to the natural frequency of the suspension system, the effects of these vibrations were not serious.

But the advent of the high-speed automobile in recent times has increased driving speeds through and beyond the resonance range, and the resulting vibrations are being increasingly felt by passengers. In order to eliminate these unpleasant and sometimes dangerous vibrations, it is desirable to know the magnitude of these oscillations as well as the amount and type of the uneven balancing that induce them. Very little quantitative data of this nature exists in the technical literature and an investigation was accordingly undertaken by the author at the California Institute of Technology, Pasadena, USA, to measure the amplitude of these oscillations for various exciting frequencies and varying amounts of static and dynamic balance on the wheel.

The investigation was limited to the left front wheel, the other three wheels being maintained in a state of true balance. In such a problem the motion of one unbalanced wheel can be regarded as that of an isolated system to the first order of accuracy, provided that the other three wheels are properly balanced. This fact has been established by J. A. Carlson, on page 62 of his 1955 Ph.D. thesis to the California Institute of Technology, entitled "Analytic and Experimental Studies of Vehicle Dynamic Behaviour."

Where the extent of the lack of balance on the front left wheel was known, measurements were made of the amplitude of linear vibrations in the vertical plane (bounce) as well as angular vibrations in the horizontal plane (wobble) simultaneously. In the accompanying illustrations, Figs. 1 and 2 show the pickups used for measuring bounce and wobble, while Fig. 3 shows the amplifiers and recorders used in the experiment. The placing of the instruments is indicated diagrammatically in Fig. 4. The tests were conducted on a 1954 Chevrolet four-door sedan car (model 210) which was equipped with $7{\cdot}5 \times 15$ tyres, and the following conditions prevailed:

1. Static lack of balance: (*a*) with a single out-of-balance weight on the outside rim (from 8 oz per in to 40 oz per in); (*b*) with the same out-of-balance weight as in (*a*) but equally divided between the inside and the outside rims (in phase); and

2. Dynamic unbalance only (96 oz-in per in to 384 oz-in per in).

In the cases of both static and dynamic unbalance, treated separately, peak amplitudes were attained at speed ranges of from 67 to 72 m.p.h., i.e., there was a clearly defined

Figs. 1 and 2 Pickups for measuring bounce and wobble. The two horizontal pickups are shown, one to the left of the king pin (Fig. 1) and the other to the right of the king pin (Fig. 2). Both pickups are equidistant from the king pin.

Fig. 3 (left) Arrangement of the amplifiers, vibration meter and recorder for measuring bounce and wobble.

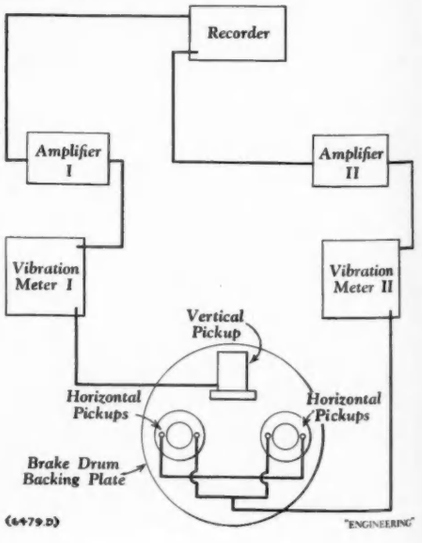


Fig. 4 (right) Diagram showing arrangement of the instruments used in the tests.

Military Rockets Could be Simplified

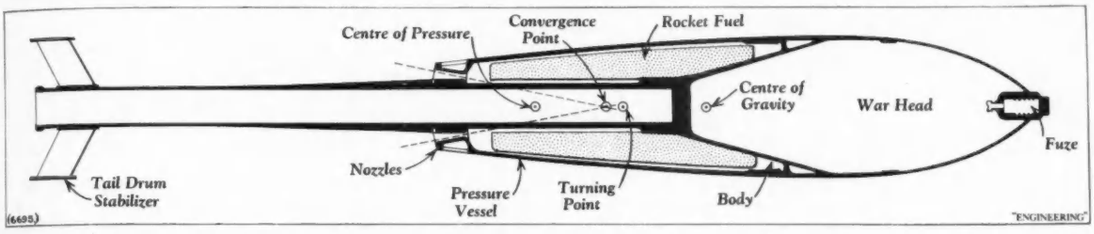
Experimental rockets have been designed and patented, which promise considerable accuracy. With such rockets, the need for artificial guidance may be eliminated. The simplicity and accuracy may also partially outdate nuclear warheads.

By Lieut.-Col. L. V. Stewart Blacker, O.B.E., T.D., p.s.c., A.F.R.Ae.S.

As long ago as 1918, the Germans succeeded in hitting a target well in the middle of Paris at a range of over 80 miles. The projectile, which was rifled, must have passed through a layer of progressively thinner air effectively some 100,000 ft thick, traversing thus about 140,000 ft, or shall we say 50,000 yards.

The master gunner concerned will have had to allow for air movements, which we call wind, in that layer, making many allowances lower down and hardly any higher up. Perhaps he made some of his wind allowances by intelligent surmise, but he had to make other allowances more easily and definitely measurable, such as those for barometric pressure, temperature of air and of propellent, for drift and for the rotation of the earth, and possibly for gyroscopic irregularities.

Today a rocket operator would need not only to make all these compensating allowances but also to provide against irregular behaviour in his rocket caused by variations in burning and in physical alignment of parts. For this purpose he now uses artificial guidances of various sorts. These are not only very costly in man-hours for design, development, production and testing, but so multifarious as to be unreliable. American sources have recently indicated that a guided missile with 100 elements in it, each 99 per cent reliable, has an overall dependability of only 35 per cent. Put more crudely, three rockets would be needed to hit a target attainable by a single inherently accurate one.



When affected by spurious forces a missile tends to turn about a point other than the centre of gravity. Known as the "turning point," it is a function of the centre of pressure and the centre of gravity.

NO NEED FOR ARTIFICIAL GUIDANCE

Recent inventions, however, have evolved rockets which will fly truly and in a manner free from errors due to irregular burning and mechanical inexactitudes. In other words they can be intrinsically accurate, free from unwanted dispersions, and free even from some of the irregularities which beset even well designed rifled projectiles, such as drift, barrel droop and jump and bore wear. The solution of the problem of attaining true flight has been one of quite simple geometry. For some six centuries past the conventional rocket maker has placed his nozzle near the extreme tail, but this is quite the least desirable position if steadiness be the object.

A nozzle at the extreme tail has a lever arm so long that any irregularity of burning is much magnified in its effect on the relation of the axis to the desired trajectory, and the same remark applies to errors of construction in the nozzle and the like. Many years ago Goddard tried nozzles near the nose without much benefit. More recently Hickman in the USA constructed "step" rockets which had in effect a plurality of nozzles of which the thrust axes coincided at the missiles' centre of gravity. By this means he reduced the dispersion very considerably in comparison with that of conventional single nozzle rockets as used in the American Service.

Aerodynamicists will, however, readily remark that a missile or aerodyne of usual shape tends to turn, if affected by any force other than that tending to push it straight ahead, not about its centre of gravity, but about its "turning point" which is a function of the centre of gravity and the centre of pressure. Therefore a plurality of nozzles should have their axes designed to meet this turning point, or a trifle behind it. This brings them well in front of the tail stabiliser of the missile, which is better unrotated. This arrangement automatically compensates for nozzle irregularity whether of burning or of fabrication.

The explanation is that, should a nozzle on the starboard side, for instance, develop more thrust than that on the port side, it will tend to make the nose of the missile incline to starboard. However, a triangle of forces comes into existence of which the transverse component tends to push the entire missile to port, which counteracts and compensates the movement to starboard. Should the error in the nozzle be one of manufacture and if for instance its axis be somewhat nearer parallel to the main axis of the rocket, there will again arise another triangle of forces whose transverse component will tend to cancel out the error that is due to the excess forward component.

The reason for making the thrust axes converge not exactly at the turning point but very slightly behind it is one of tolerances, that is to say, that the most forward position of convergence of the thrust axis to the main axis must take into consideration possible angular momentary variation in this thrust, so that it must not come in front of the turning point. In practice this distance is very small. The angle of convergence of these nozzles need not be large, but depends on individual design requirements.

Another source of rocket inaccuracy has, in the past, derived from the fact that propellents have been quick burning, so that they tended to be wholly consumed at an early point in the trajectory, or even, as in the infantry rocket launcher, entirely within the tube. The arrival today of slower burning fuels makes it possible to continue their effect, at low pressure, all the way, or virtually all the way, to the target. Thus the hitherto indeterminate "all-burned" position may be a worry of the past.

Such a rocket is eminently well adapted to be discharged, with a suitable gas-check, from a smooth bore gun. Based on this, an equipment with a very moderate muzzle energy promises to afford severalfold greater performance than a conventional rifled piece. At the other end of the missile scale there is no valid reason why such rockets should not be built in two or three stage form, to achieve ranges measured in hundreds of miles.

NUCLEAR WARHEAD UNNECESSARY

The obvious present day warhead for such a weapon would at first blush seem to be in the fission category; but this sort of warhead has a most serious drawback, especially to the minds of those students of Clausewitz who believe war to be a continuance of policy. This is that it affords an excuse for retaliation in kind.

It is reasonable to consider this matter from the target end, where three general types present themselves. The first is a town, like Hamburg for instance. Clearly there is little value, either military or political, in killing ten thousand times over the people who happen to be in the centre of a nuclear blast like that of Hiroshima. Once is enough; even if we do not follow Napoleon to the extent of believing that it is the number of

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Concluding **Effects of Unbalanced Wheels**

neighbourhood of resonance in the frequency range of 13·5 to 14·5 c.p.s. A static lack of balance of 40 oz per in on the outside rim of the wheel gave a maximum double amplitude in bounce of 0·22 in, and a maximum double amplitude in wobble of 0·75°. When the lack of balance was equally divided between the two rims (in phase), the amplitude in bounce was reduced to 0·15 in and wobble to 0·65°. Dividing the lack of balance equally between the rims brought about better balance conditions, as was to be expected.

With a dynamic lack of balance alone, amounting to 384 oz-in per in, the maximum double amplitude in bounce was 0·11 in and the maximum double amplitude in wobble 1·35°. This result shows that for all practical purposes the static balancing of tyres is necessary and sufficient. A static lack of balance of 8 oz per in on the outside rim was not noticeable, but vibrations began to appear at about 16 oz-in per in. When the weights were divided equally between the rims, the threshold of vibration consciousness increased to 24 oz per in. With a dynamic lack of balance alone, of 288 oz-in per in, very slight vibrations were noticed in the steering, which confirms the observation above that for all practical purposes static balancing is necessary and sufficient.

The author's thanks are due to Professor H. Lurie of the California Institute of Technology, for his interest and guidance, and Professor A. Ramachandran of the Indian Institute of Science, Bangalore, for his constant encouragement.

The foregoing is a digest of a thesis presented by the author in 1956 for the degree of Mechanical Engineer at the California Institute of Technology. Copies of the complete paper, entitled "The Effect of Wheel Unbalance on Vehicle Dynamics," may be obtained from the Institute's general library., 1201 East California Street, Pasadena 4, Cal., USA, price $3·50.

IMPACT TESTING MACHINES

New Data on Support Conditions

By J. H. Lamble,
D.Sc., M.I.Mech.E., M.I.N.A.
College of Science and Technology, Manchester

Little is known of what happens when the support conditions of impact machines are varied. For this reason the following observations, which were made when the Strength of Materials Laboratory of the Manchester College of Science and Technology were moved to new premises, may be of considerable value to others in this field.

IZOD IMPACT TEST

A number of specimens, cut from the same bar of material, were tested at an ambient temperature of 63° F. In each case the machine was on a level concrete floor. The test details were as follow: Avery Impact Machine, "A" frame type, capacity 120 ft-lb, impact velocity 11 ft per sec. British Standard 3 notch specimens, 10 × 10 mm. cross-section with 45° notch 2 mm deep. Specimen material, 3½ per cent Ni, 0·5 per cent Cr, steel, Fox 140 grade.

Results

Support condition	Impact
(*a*) Machine grouted to concrete base	50·2 ft-lb
(*b*) Machine resting on steel plates	48·8 ,,
(*c*) Machine resting on steel rollers, ¾ in dia.	50·4 ,,
(*d*) Machine resting on 3 in cubes of flexible rubber, placed one at each corner	43·8 ,,
(*e*) Machine resting on 2 in of damp sand	39·8 ,,

CHARPY IMPACT TEST

Again all specimens were cut from the same bar (of mild steel) and in the first five tests the machine was on a level concrete floor. The ambient temperature in this case was 68° F. The test details were as follow: Loenhausenwerk Impact Machine, type LOS 30, capacity 30 kg-m. (217 ft-lb), striking velocity 5·6 m. per sec (18·37 ft per sec). Standard DVM specimen to DIN 50 115 of May, 1952, 10 × 10 mm. cross-section, " keyhole " notch 2 mm. dia., depth of material at root of notch 7 mm., length 60 mm., span under test 40 mm.

Results

Support conditions	Impact
(*a*) Machine grouted to concrete base	64·0 ft-lb
(*b*) Machine resting on steel plates	63·5 ,,
(*c*) Machine resting on steel rollers, ¾ in dia.	66·5 ,,
(*d*) Machine resting on ½ in thick rubber mats	63·0 ,,
(*e*) Machine resting on 2 in of damp sawdust	62·0 ,,
(*f*) Machine supported a few inches above the floor by a wire rope at each corner. The length of each rope was 8 ft	62·0 ,,

Two further tests were carried out with both machines permanently grouted to the floor and using the same mild steel as for the Charpy tests enumerated above. For the Izod impact tests, with 3 notch B.S. cantilever type specimens, the impact value was 81·0 ft-lb at 68° F. For the Charpy test an Izod notch was used, i.e. the single notch B.S. beam type specimen, and the impact value was 83 ft-lb or 14·4 kg-m per sq. cm based on the cross-sectional area at the root of the notch.

It is evident that in this type of Charpy impact testing machine there is little significant difference in the results however the machine is supported, but with the Izod tests as carried out on the Avery machine a wide margin of difference may be expected.

For those who wish to theorise, the most significant difference in the action of these machines was observed when the machines were mounted on rollers. Here the Izod specimen received its blow when the machine and the striker were travelling in the same direction. With the Charpy machine the striker and the machine were moving in opposite directions at the moment of impact, and at about the maximum velocity in these directions.

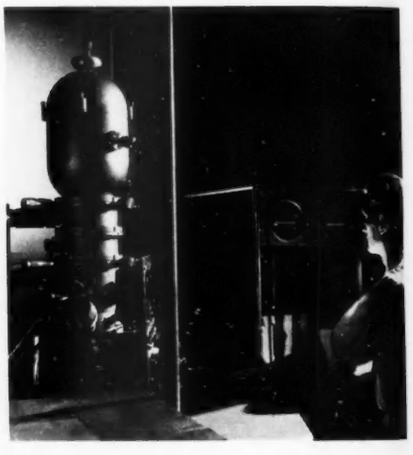
METAL TUBE RESEARCH

The manufacture of metal tubes gives rise to many problems, some of which are of a fundamental nature and require full laboratory facilities if satisfactory solutions are to be found. To cope with this and at the same time to explore new fields of activity, Tube Investments Limited have built a research centre at Hinxton Hall, Cambridge, which was recently declared open by its chief executive, Sir Ben Lockspeiser.

Although the research centre began to operate at Cambridge five years ago, final construction of buildings and installation of equipment has only been completed during the past few months. The centre's primary function is to undertake applied research aimed at reducing costs, improving quality and introducing new products but, as is always the case, such work as this involves a high proportion of research of a fundamental nature.

Among the most interesting of their basic research undertakings is that of investigating the properties of non-metallic " whisker " crystals These tiny needles, which are grown in one of the laboratories, have tensile strengths of the order of 1,000 tons per sq. in and could forseeably be used to make engineering materials with similar orders of mechanical strength. Furthermore, since the crystals can be grown from refractory substances, it may be possible to combine this exceptional strength with high thermal resistance.

Much of the apparatus used at Hinxton Hall is of the latest design and to some extent unique. One of the most impressive pieces of equipment in this category is their new X-ray scanning microanalyser, which promises to be a most useful general instrument for metallurgical research. By scanning an electron beam, in much the same way as a television tube, it provides a picture of the surface of a metal from which a quantitative analysis can be made. It is said to be capable of showing the distribution of elements on a finer scale than has yet been achieved by any other instrument. Originally developed by the Cavendish Laboratory, Cambridge, it is now scheduled for production by the Cambridge Instrument Company at a cost of about £16,000.



The development of ultra high strength materials is an important aspect of work at Tube Investment's research laboratory at Hinxton Hall. The X-ray scanning microanalyser is proving invaluable in fundamental metallurgy.

Concluding **Military Rockets Could be Simplified**

men we frighten rather than the number we kill, which gives us victory.

Hamburg was destroyed quite adequately, mainly by a quantity of incendiaries of which we now know the magnitude. Such small incendiaries can now be transported to the target in the form of shrapnel, in the warheads of rockets of adequate size and power. Clearly very great numbers of such small incendiaries will be needed and correspondingly large numbers of these shrapnel-form rockets. No doubt many more rockets must be projected than the sorties of bombers of the Second World War. They can, on the other hand, be incomparably simpler and cheaper, but what is much more important, they will not be manned. Nearly eighty thousand men of Bomber Command were killed over Germany and Japan !

So much for built-up areas and installations. The next type of target may be the deployed infantry division on foot or carried. Against this we may revive the tactics which Sir Geoffrey Salmond used with such success against retreating Turks in 1918. A large rocket may now have another shrapnel type of warhead in which the components are small high explosive filled grenades.

In the design of such a war head, the critical problem will be that of the fuse. It will be important to prevent these grenades from burying themselves or even to cause them to rebound before detonation. Then again it will be important to open out the shrapnel war head in such a way as to distribute its contents evenly, efficiently and from the best height, whether by a proximity fuse or by other possible means, such as the radio-altimeter.

The employment of small containers of recently developed chemical biologically disabling substances must not be overlooked.

The third type of target will be the armoured force whether deployed or concentrated. The attack of this may well be summed up in the word Napalm, again released from our very large but essentially simple and accurate rockets, though shaped charges will also be valuable.

Note: The Patent referred to is primarily UK Pat. 773190/1953.

On the Shelf

By Frank H. Smith

Just had a fascinating chunk of stuff from BX Plastics Limited (Brantham, Near Manningtree, Essex). It looks like the waxed paper they put round sliced loaves and it is called Transpasene (anybody seen the Transpasene?). It consists of a transparent film with a semi-opaque backing. You peel off the backing and press the film over a printed surface. It adheres and there you have a fully protected but legible document. If you want to have a price list and other dope drop a line to BX at Higham Station Avenue, London, E4, or the other address I gave.

The Swedish firm of ASEA is world-renowned and they now produce a very fine journal called *Asea Research*. English, French and German are the languages and the publication will be "occasional." There is no price shown and I *think* it may be goodwill. Address—Asea Research, Asea, Västerås, Sweden.

The only publication of its kind in Britain, they say, is *Scientific Research in British Universities*, published by DSIR and obtainable from HMSO. A casual glance through the subject index reveals some most extraordinary subjects available—toads, obesity in children, lymph, lumbar puncture (that rings a bell), energy transfer (I could do with some if its any relation to blood transfusion)—covering over 50 pages in all.

Quality Bearings Limited, of 218-221 Bedford Avenue, Slough, produce a news sheet called BETA (no relation to any reactor) to "serve the interests of users of precision bearings." Three or four issues a year are contemplated and as it is only four pages, it will not take up much room. A measure of the usefulness of the contents is given by the first article, "Torque and Torque Testing of Instrument Ball Bearings."

The British Welding Association of 29 Park Crescent, London, W1, are to provide a cover-to-cover translation of a Russian journal whose title I cannot reproduce (not having a Volga typewriter) but the English of which is *Welding Production*. The original has 48 pages and the subscription will be £4 ($12) for the first April-December batch and thereafter £5. An explanatory booklet is available.

The Engineering Centre ("Britain's only Permanent Engineering Exhibition") of Stephenson Place, Birmingham, 2, has changed, with Volume 2, No. 1, the form of its *news letter*. More illustrations and new layout are intended to give a better idea of the centre's activities. I'm glad about this because it gives me an excuse for mentioning a publication I've not hitherto encountered.

Chapman and Hall have a specialist list (Section 10) of books on electrical engineering and electrotechnology.

From the Office of Technical Services, US Dept. of Commerce, Washington 25, D.C., you can now get Publication BP 131008. This will tell you what literature is available (in review form) on "Injection and Combustion of Liquid Fuels" and will cost you $9. This can *not* be obtained through HMSO.

If you are tied of cover-to-cover stuff and want to try the original Muscovite, the 1960 list of Russian periodicals is now available from Collett's Holdings Limited, 45 Museum Street, London, WC1. For good measure they will probably throw in the journals of the Czechoslovak Academy of Sciences, a list of books and periodicals on learning Russian, and assorted lists of dictionaries, readers and grammars.

More Russian. It's getting quite a disease, isn't it? The American Institute of Physics (335 East 45 Street, New York, 17) does EIGHT TIMELY SOVIET PHYSICS PERIODICALS (their caps and phrasing). A list and particulars would take up the column so send an air letter to the address given for what they call a flyer but what we might call a publisher's leaflet.

CARS TO DRIVE AND DREAM ABOUT

Automobile Year No. 6 1958–59. *Edita SA, Box 1109, Lausanne 1, Switzerland;* and *G. T. Foulis and Company Limited, 7 Milford Lane, London, WC2.* (Price 50s.)

There are several motoring reviews published each year, but this 6th edition of *Automobile Year* stands in a class on its own, lavishly produced with a pleasant format and layout, beautifully illustrated with many full-colour and black and white reproductions, and catering for everyone interested in motoring or in the sport.

Reviews of this type serve to keep in perspective the ever changing scene of the automobile industry as it is very easy to forget when certain events actually happened; and, conversely, the futuristic sketches are valuable in judging how the trend in design is developing. It is obvious then that the scope of this book is very wide, and while there is not space here to deal in detail with each chapter, the following résumé will give an idea of the contents.

Gordon Wilkins—the English editor—reviews the world's automobile industry, and this is amplified by two interesting articles on the growth and development of the automobile in Australia and Russia. Of more specialist nature are the features on the history of motor car suspension; the illustrations are easy to understand and will enable many people to appreciate how "independent front suspension by wishbones and coil spring" really operates. Of a more technical nature is P. Eppendahl's "Tuning Production Engines," now common practice with a great many owners.

Diana Bartley produces a frightening, fact ridden report on how to reduce crash casualties, based upon the findings of the American Cornell University automotive crash injury research group. Statistics can, we know, be made to prove almost anything but there is no denying that the problem of road casualties throughout the world, and particularly in the United Kingdom, is very serious indeed. Many of the findings of the group have been, and doubtless will be, implemented in future car design and will contribute towards reducing accidents and their effects. This is far from a complete answer to the question, and it is our road system and traffic manners that need urgently overhauling. Such a programme of rethinking, when completed, should be adequate for conditions as they will be in the future, and not as they are today or were five years ago.

The section on special bodies and dream cars deserves particular mention. Although these concepts have little immediate practical value, they are very necessary, since they are an outlet for the designer's creative art and allow him to express his thoughts in something tangible; and while they may appear ultra-futuristic now, it may not be many years before some of these "visions," or at least modified versions, are rolling off the production line in quantity.

The second half of the book is devoted to "The Sport." The fascinating story of the battle for the driver's world championship is retold, with many very fine photographs, backed up by lap charts, grid positions and full results—all accurately and clearly tabulated for each Grande Epreuve. The world championship sports car series is covered very fully and there are some quite beautiful colour shots of Sebring, Targa Florio and Le Mans. There are also many detailed photographs of various F1 and sports cars and a pull out sectional drawing of the Aston Martin DBR1/300.

This book, which is also printed in French and German, is now well established and provided it maintains the very high standard it has set itself, must be a regular addition to the bookshelf of every enthusiastic follower of motoring when it is published each year.

DAVID BROWN

PERFORMANCE RATING

The Autocar Road Tests Spring 1959. *Iliffe and Sons Limited, Dorset House, Stamford Street, London, SE1.* (6*s*)

The reports on road tests which appear regularly in the weekly editions of *The Autocar*, are now published in accumulated form twice a year instead of only once, as previously. This spring edition describes 21 cars, mostly British, and gives a very useful picture of their characteristics and capabilities. The tests are comprehensive and, in addition to a table of performance data, the reports give much information on points of behaviour which cannot conveniently be expressed in figures. A little more consistency with regard to the information published in the data table would, however, be welcome. For example, the frontal area is given in some cases and not in others, and there are two different methods of expressing the stopping power of the brakes.

It is sad to see the now generally accepted exaggeration of the car speedometer. With one notable exception, the A 95, every speedometer exaggerates appreciably, sometimes more than 10 per cent. This can only be a deliberate policy since in no case is the error the other way round, and the ludicrous situation has arisen now that for an extra payment one can obtain a guaranteed-accurate speedometer. This exaggeration may have had some point, even though unethical, in the days when it was necessary to demonstrate that our cars would apparently go faster than other peoples', but it hardly seems necessary today.

It also seems curious that after so many years of car manufacture in this country it is not possible to have equally good brakes on all cars. If good brakes can be fitted to some cars, as is evident from these tests, why should other cars fit brakes so much less efficient? The pedal pressures also vary considerably. One would think that it ought to be possible to make cars which require not more than 90 lb pedal pressure to give a deceleration of 0·9 *g*. It is also interesting to note how performance and price are often quite independent

It is a pity that some better method of describing steering characteristics has not been used. While it is useful to know the number of turns from lock to lock and the turning circle, a better comparison of the characteristics of different cars would be obtained if the fraction of a turn of the wheel required to negotiate a 100 ft radius curve were given.

Some ten years ago, I examined the data available for the then current cars and noticed that the alleged streamlining had in fact virtually no effect on the maximum speed of the car, it being dependent only on the power and the cross-sectional area. The maximum speed was in fact very close to 57 times the cube root of the horse-power per square foot. This remains true today, there being still no appreciable benefit from body shape, reduction of cross-sectional area being the only worthwhile way in which speed can be increased for the same power. It may also be worth noting, as was true ten years ago, that the number of seconds taken for the standing quarter-mile is still given by 82 divided by the cube root of the horse-power per ton, and the petrol consumption is approximately 36 divided by the square root of the engine swept volume measured in litres. These three formulae give a convenient basis on which to judge the performance of any car.

The calculated performance figures for the 21 cars in this series of tests have been worked out by the above method—using only four para-

Car	Maximum Speed			Standing Quarter Mile			Fuel Consumption	
	P/A	Calculated $57\sqrt[3]{P/A}$	Actual m.p.h.	P/W	Calculated $82/\sqrt[3]{P/W}$	Actual secs.	$\frac{36}{\sqrt[3]{L}}$	Actual m.p.g.
AC	8·35	116	117	128·2	16·3	16·5	26	22
A40	2	72	72	37·9	24·4	24·5	37	38
A95	4·5	94	90·3	58·3	21·1	21·7	22	21
BMW	1·11	59	61·6	13·6	27·0	24·5	47	46
Berkeley	2·72	80	80	56·8	21·3	22·4	52	33†
Borgward	3·66	88	87·5	61·8	20·8	21·7	30	33
Citroen ID19	2·93	81·5	86·5	48·4	22·5	22·3	26	26
Daimler*	5·9	103	101·2	76·6	19·3	20·2	18·5	18
Zagato	3·4	86	95·4	63·0	20·6	20·0	42	43
Fiat 1200	2·9	81	86	52·2	22·0	21·6	33	35
Frisky	1·14	59·5	56	32·8	26·6	27·2	64	57
Minx	2·78	80	77·6	44·8	23·1	23·2	29	29
Snipe	5·18	98·5	94·5	66·5	20·2	21·0	22	18
Jaguar*	8·8	118	113·5	113·7	17·0	17·8	18·5	14
Lancia	5·35	100	102·3	56·8	21·3	20·2	23	21
Mercedes 220 S	5·6	101	98·3	83·1	18·8	21·0	24	25
Minor	2·0	72	69	38·4	24·4	23·9	37	38
Traveller	2·43	77	76	41·5	23·7	24·2	29	26
Princess*	5·75	102	98·7	67·9	20·1	20·6	18	12
Gazelle	3·06	83	82·2	45·8	22·9	22·4	29	31
Vanguard*	3·16	84	79·4	48·3	22·5	23·9	25	25

meters (power, weight, cubic capacity and cross-sectional area)—and compared with the results obtained in the tests. The comparative results appear in the accompanying table, which shows that performance can be calculated within quite close limits. It is also evident in some cases why a car does not come up to calculated performance, for example loss of power in automatic transmissions, though it is not so clear why the Abarth Zagato should have a so much higher maximum speed than the calculation indicates; on the other hand, the testers do state that it takes a long time to reach its maximum.

J. S. BLAIR

The calculations make use of the following formulae:

Maximum speed (m.p.h.) $V = 57\sqrt[3]{P/A}$

Standing quarter mile $T = \frac{82}{\sqrt[3]{P/W}}$

Fuel consumption $M = \frac{36}{\sqrt[3]{L}}$

where

V = m.p.h. P = max. brake horse power
A = cross-sectional area (sq. ft)
M = miles per gallon
L = cubic capacity (litres)
W = weight (tons)

* Automatic transmission. Note lowered performance.
† Two stroke (formula does not apply).

MOTORIST ABROAD

Go Continental—By Car. By WALTER HUTTON. *Iliffe and Sons Limited, Dorset House, Stamford Street, London, SE1.* (17*s* 6*d*)

Mr. Hutton's book is opportune since the habit of taking Continental holidays is greatly on the increase. And at this time, with the Motor Show approaching, many will be starting to consider where they will motor to next year. The book is particularly useful in that it lays emphasis on the avoidance of popular routes and, in fact, deals almost entirely with roads clear of holiday traffic. The amount of detail is remarkable, not only with regard to places and how to get to them, but on such matters as preparation of the car, the iniquities of customs restrictions, the giving of tips and lifts, and the right sort of map to use. It is most useful for both the novice and the expert taking a car abroad to know on what occasions he may be unable to find a petrol pump; what roads are one-way and at what time of day; that the early morning is the best time to tackle Alpine passes; and the dangers of driving down long descents without changing to a lower gear. Although the author mentions that most Alpine passes are not particularly steep, he does not mention what usually surprises the novice, namely, their exceptional length.

It is not only driving that is considered, but skiing, including water-skiing, photography, the towing of boats or caravans, and the best things to eat and, particularly, to drink. Indeed, the author devotes much space to the description of wines and the wine country. The book is made very readable by little odd asides, for example, as to the best type of Italian cigarette to buy, and the quantity of grapefruit you are likely to find on your plate in Italy.

The descriptions of touring in different countries are nicely interspersed with notes on mountaineering by car, winter sports, and so on. One feels that the author has close personal knowledge of the roads and places which he describes; indeed, it is only too obvious that he is much less enamoured of Spain than of the other countries. The various journeys which he describes are illustrated by a large number of maps. These would be even more useful if they had an indication of scale and of the direction of north, but they really require a full-size map to be used with them. Needless to say, the author gives information as to the best sort of full-size map to get!

The photographic illustrations are effective and well printed, but it is a pity that so many of them are obtained from tourist offices or information bureaux, particularly since photography appears to be one of the author's hobbies. It is also a pity that such an excellent book is not provided with an index, but one hopes that in any future editions this will be attended to.

J. S. BLAIR

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Spot Welding. W. D. VICK LTD., 28 Station Road, Acocks Green, Birmingham, 27. 15 and 20 kVA heavy duty spot welders for continuous operation; water cooled electrodes. Four heat changes. Bulletin 101.

Resin Bonds. BRITISH RESIN PRODUCTS LTD., Devonshire House, Piccadilly, London, W1. Cellobond adhesive and binder resins for many purposes. Adhesive, laminating, polyesters, foundry types, rubber compounding, etc. Data booklet No. 1.

Welding Fittings. FOSTER BROS. LTD., Lea Brook Tube Works, Wednesbury, Staffs. Welding fittings and accessories for fabricated steel pipe work; bends, branches, reducers, flanges, etc. Illustrated catalogue.

Plastic Welder. RADIO HEATERS, LTD., Wokingham, Berks. Models FW2 and FW3 general purpose plastic sheet welders of 1¼ kW and 3 kW ratings. Also accessories. Leaflets.

Arc Welding. PHILIPS ELECTRICAL LTD., Century House, Shaftesbury Avenue, London, WC2. Arc welding plant and accessories; 175 and 350 A, one or two operators. Folder.

The Reviewers

Mr. David Brown is chairman and managing director of the David Brown organisation, the large industrial group of which Aston Martin and Lagonda are members. Mr. Brown's decision to take over these two famous car firms in 1947 and 1948 virtually saved them from extinction and has been amply justified by the recent successes of Aston Martin cars on road and track. A successful racing motorist in his youth, Mr. Brown takes a close personal interest in the Aston Martin motor-racing team and attends as many of the principal races as his business commitments will allow. He is a member of the Institution of Mechanical Engineers and of the Institution's Automobile Division; he is also an Associate Fellow of the Royal Aeronautical Society and holds a pilot's licence. This year he achieved the distinction of winning the Sports Car championship with his Aston Martin cars—the first time Britain has ever won this honour.

Dr. J. S. Blair is assistant director for research with Stewarts and Lloyds, Limited, and a well known writer on automobile affairs. He is the author of *The Skilful Driver* and some fifty technical papers and articles. He is a D.Sc., an M.I.Mech.E. and a Mem.A.S.M.E.

NEW BOOKS

The Indian and Eastern Engineer Centenary Number 1858-1958. *Sohrab House, 235 Dr. D. Naoroji Road, Bombay 1*; and *Iliffe and Sons Limited, Dorset House, Stamford Street, London, SE1.* (*Rs* 15·00)

A well-produced volume of 295 pages containing, as one would expect, articles by Indian authorities reviewing 100 years of progress in their respective fields. Among strangers in the midst are articles on Building Research in Canada by R. F. Legget and 100 years of Aerodynamics which von Karman squeezes in since 1868. It will surprise many people to know that the original *The Engineer's Journal and Railway Chronicle of India and the Colonies* first appeared as long ago as 2 January, 1858, but it will surprise nobody who takes *The Indian and Eastern Engineer* today that they have produced such an excellent and interesting comemorative volume.

The Performance and Design of Direct Current Machines. By ALBERT E. CLAYTON and N. N. HANCOCK. *Sir Isaac Pitman and Sons Limited, London.* (40*s*)

A third edition (1927, 1938) revised to conform to modern requirements. Aimed at B.Sc. (Eng.), Grad. IEE and HNC students.

Stark Broadening Functions for the Hydrogen Lines. By ANNE B. UNDERHILL and JOHN H. WADDELL. National Bureau of Standards Circular 603. *Superintendent of Documents, US Government Printing Office, Washington* 25, *DC, USA.* (16 *cents*)

The data can be used to compute self-consistent profiles of the hydrogen lines in stellar spectra.

Chemical Engineering Calculations. By ERNEST J. HENLEY and HERMAN BIEBER. *McGraw-Hill Publishing Company Limited, London.* (70*s*)

". . . integrates the material usually covered in stochiometry and thermodynamics I. It includes a rigorous and comprehensive treatment of 'first law' thermodynamics and phase diagrams and an exposition of material-balance calculations."

Chemistry Made Easy. By SNELL and SNELL. *Chemical Publishing Company Incorporated, New York.* ($10·00.)

An extension of the Do-It-Yourself to self-tutoring. Simple questions appear at the end of each chapter with stinkers at the end of each volume (the book is three volumes in one). You have three paginations, three contents lists and three indexes. Slightly confusing but you are meant to plough through from beginning to end.

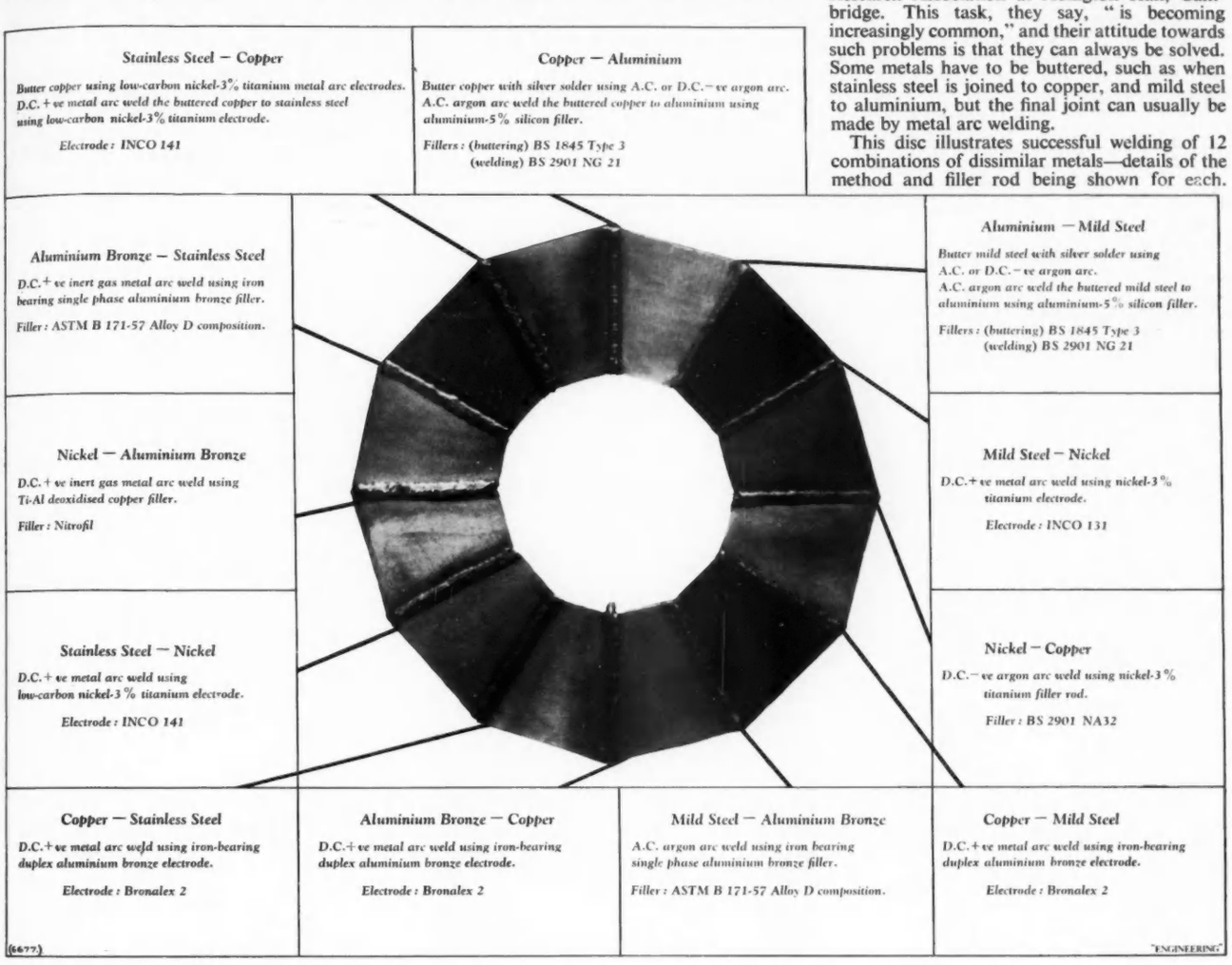
Radio Circuits. By W. E. MILLER and revised by E. A. W. SPREADBURY. *Iliffe and Sons Limited, London.* (15*s*)

The last edition was in 1951 and the opportunity is now taken to acquaint the reader with the latest developments in " steam " radio.

WELDING DISSIMILAR METALS

A number of problems in joining dissimilar metals have been solved by the British Welding Research Association at Abington Hall, Cambridge. This task, they say, "is becoming increasingly common," and their attitude towards such problems is that they can always be solved. Some metals have to be buttered, such as when stainless steel is joined to copper, and mild steel to aluminium, but the final joint can usually be made by metal arc welding.

This disc illustrates successful welding of 12 combinations of dissimilar metals—details of the method and filler rod being shown for each.


Stainless Steel — Copper
Butter copper using low-carbon nickel-3% titanium metal arc electrodes. D.C.+ve metal arc weld the buttered copper to stainless steel using low-carbon nickel-3% titanium electrode.
Electrode: INCO 141
Copper — Aluminium
Butter copper with silver solder using A.C. or D.C.−ve argon arc. A.C. argon arc weld the buttered copper to aluminium using aluminium-5% silicon filler.
Fillers: (buttering) BS 1845 Type 3 (welding) BS 2901 NG 21
Aluminium Bronze — Stainless Steel
D.C.+ve inert gas metal arc weld using iron bearing single phase aluminium bronze filler.
Filler: ASTM B 171-57 Alloy D composition.
Aluminium — Mild Steel
Butter mild steel with silver solder using A.C. or D.C.−ve argon arc. A.C. argon arc weld the buttered mild steel to aluminium using aluminium-5% silicon filler.
Fillers: (buttering) BS 1845 Type 3 (welding) BS 2901 NG 21
Nickel — Aluminium Bronze
D.C.+ve inert gas metal arc weld using Ti-Al deoxidised copper filler.
Filler: Nitrofil
Mild Steel — Nickel
D.C.+ve metal arc weld using nickel-3% titanium electrode.
Electrode: INCO 131
Stainless Steel — Nickel
D.C.+ve metal arc weld using low-carbon nickel-3% titanium electrode.
Electrode: INCO 141
Nickel — Copper
D.C.−ve argon arc weld using nickel-3% titanium filler rod.
Filler: BS 2901 NA32
Copper — Stainless Steel
D.C.+ve metal arc weld using iron-bearing duplex aluminium bronze electrode.
Electrode: Bronalex 2
Aluminium Bronze — Copper
D.C.+ve metal arc weld using iron-bearing duplex aluminium bronze electrode.
Electrode: Bronalex 2
Mild Steel — Aluminium Bronze
A.C. argon arc weld using iron bearing single phase aluminium bronze filler.
Filler: ASTM B 171-57 Alloy D composition.
Copper — Mild Steel
D.C.+ve metal arc weld using iron-bearing duplex aluminium bronze electrode.
Electrode: Bronalex 2
(6677)
"ENGINEERING"

Plastics for

LORRIES

Dennis Brothers Limited have begun the production of reinforced plastics parts for the front details of their custom-built Pax vehicles. The new vehicles have the front wings, the radiator surround, valance and lamp housings made from reinforced Bakelite polyester resin. A metal tread plate is fixed to the flat top of the valance, while the lamps and other fittings are attached in accordance with normal metal practice. The parts are painted in the same way as the metal fittings.

BOATS

A contract calling for the quantity production of plastics hulls for the Alpha sailing dinghy has been placed with Bristol Aircraft Limited by Bossoms of Oxford. The hull has a plastics foam reinforcement injected into the cavity between its inner and outer glass-fibre shells. This gives the craft permanent buoyancy.

CARS

Bristol Aircraft Limited are also due to begin quantity production of glass fibre bodies for the 130 m.p.h. Lotus Elite grand touring car. This contract is one of the largest ever awarded to a plastics manufacturer by a British car firm. A unique feature of this car is the chassis/body construction. The chassis and body are moulded in reinforced plastics and are fused together to form a strong and rigid integral structure. The car was designed by Mr Colin Chapman, the managing director of Lotus Cars.

BEST OF RUBBER AND PLASTICS

By combining rubber with plastics, compounds have been made which combine some of the best properties of both. One example is the mixing of nitrile rubbers with pvc. The resulting compounds are still vulcanisable over nearly the whole range of compositions, but to the already good strength, oil and abrasion, and temperature resistance of the nitrile rubber are imparted ozone resistance, non-inflammability and even better mechanical properties. This has been recognised for several years, but could not be exploited until rubber and pvc existed in a form which could be easily processed. These now exist. ICI make Butakon A which can readily be mixed with several pvc polymers that are on the market.

Ozone resistance is rapidly increased by addition of pvc. With only 10 per cent, the compound will resist 1 per cent for more than 20 minutes, which is a level at which no failures in aircraft have been reported in the past four years.

The non-inflammability is dependent on the plasticiser used—this having to be added for retention of low temperature flexibility. Tritolyl or similar phosphates impart non-inflammability, and thus make the compounds acceptable for conveyor belting and mine trailing cables.

Unfortunately, maximum properties of the mixtures are only obtained if at some time in the compounding process the pvc is brought to its gelation temperature of about 150° C. If this occurs at the vulcanisation stage the tensile strength and elongation are, for instance, doubled. Given this, the compound mixtures seem to have several attractive properties, and are additionally easy to mould and extrude.

COMBINED PLASTICS VESSELS

The title is perhaps a little ambiguous, but means that a number of vessels shown in the illustration below are made from a combination of two plastics. The aim of the makers—Cawley Plastics Limited, of Weybridge—was to combine the strength of the glass-reinforced polyester with the corrosion resistance of pvc by lining the former with the latter. The two are chemically bonded. This then marks a further attempt to improve the corrosion resistance of reinforced plastics. Last week,

Glass reinforced plastics vessels are lined with pvc to give better corrosion resistance.

on page 323 of this journal, was featured the Terylene reinforced overlay, used for a similar purpose, but giving better abrasion resistance than pvc.

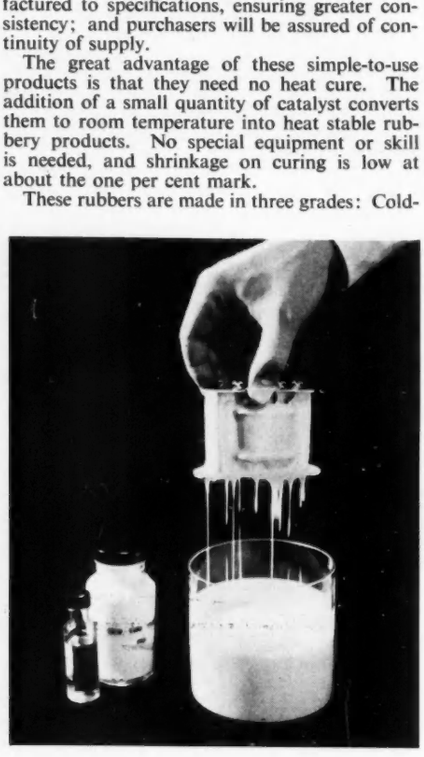
The illustration is intended to feature the vessels—not the lorry. The one thing that may be deduced from it is that the name given by Cawley to this dual construction is Tufplas. The size of the vessels excites the makers into saying that they believe them to be the biggest ever made. Even these, however, will be dwarfed by a chemical vessel now under construction which is 8 ft in diameter, 20 ft in height, and which will hold 6,500 gallons.

COLD CURING RUBBERS

Midland Silicones Limited of 68 Knightsbridge, London, SW1, have promoted their cold curing silicone rubbers from an experimental to a bulk production basis. This will benefit customers in two ways: the products are now being manufactured to specifications, ensuring greater consistency; and purchasers will be assured of continuity of supply.

The great advantage of these simple-to-use products is that they need no heat cure. The addition of a small quantity of catalyst converts them to room temperature into heat stable rubbery products. No special equipment or skill is needed, and shrinkage on curing is low at about the one per cent mark.

These rubbers are made in three grades: Cold-



An audio output transformer being encapsulated in cold-curing silicone rubber.

Cure Silastomer 9159, the heavy grade which has the consistency of builder's putty and can be moulded, milled or calendered; Cold-Cure Silastomer 9160, the medium grade which can be spread or applied by caulking gun; and Cold-Cure Silastomer 9161, the liquid form suitable for dipping, injection or impregnating.

Typical applications of these rubbers are for encapsulation, caulking, sealing, filleting and making flexible moulds from which resins and other materials may be cast. They can be used at temperatures from 250° C to − 50° C, possess excellent dielectric properties and give protection against moisture, dust, oxidation and mechanical shock.

EASY PROCESSING SILICONE RUBBERS

Three general purpose silastomer rubber stocks with improved processing characteristics have been developed at the laboratories of Midland Silicones Limited, at Barry in South Wales. They are called development products 2452, 2453 and 2454.

All three stocks are white rubbers and meet the requirements of the Ministry of Supply Air Materials Specification DTD 818, Class L. In hardness, they are similar to the established 50, 60 and 70 Silastomers, but they are superior to these in the following ways. During processing and fabrication, they are less sticky on the mill or calender; the properties are more reproducible, mouldings, extrusions and calendered sheets have superior surface finish; and the new grades have lower compression set, higher tear strength and low shrinkage on curing. Thick sections can be more easily fabricated, and these grades have greatly improved resistance to boiling water while possessing the same good heat ageing properties as Silastomers 50, 60 or 70. They are not, however, suitable for preparation of cellular products.

The most obvious application of the new rubbers is for cable covering by extrusion, but as they are also easily moulded and calendered there are many other possibilities.

MARINE PAINT TESTS

Large scale experiments with a variety of paints will be carried out on the British Petroleum Tanker Company's newest ship, British Kiwi, when she is commissioned this year. British Kiwi, which was launched from Smith's Dock Company's yard at Middlesbrough on 21 July, is the first ship built for BP Tanker Company in which all the steelwork has been shop blasted before erection.

Advantage is being taken of this method of surface preparation on the outside of the ship to compare the performance of conventional underwater paints with a vinyl composition paint and an epoxy resin based paint.

Epoxy resin based paints, supplied by nine different manufacturers, will be applied to the internal walls of most of the cargo and ballast tanks; an isocyanate paint will also be used. In certain of the cargo ballast tanks, cathodic protection will be employed in conjunction with the painting of the deckhead. In one tank all ten paints will be compared. Thus, every oil-carrying tank on the ship will have protection against corrosion, except one which will be left bare, at least at first, for comparative purposes. It will be at least two years of operating conditions before any definite results can be expected from the experiments.

ANTI-TARNISH FOR SILVER

An electrolytic treatment for protection of silver against tarnish has now been approved by the Ministry of Supply and given the reference DTD 900/4636. It is the Argalin process made by Roto-Finish Limited of Hemel Hempstead.

This process is being used for electrical contacts as well as the more obvious use for cutlery and silverware. With contacts, it offers protection during storage and transport before assembly. Perhaps surprisingly, the very thin, colourless film formed by the process does not affect the solderability or contact resistance.

HARD FACING ELECTRODES

Increased savings in the maintenance costs of heavy duty plant can now be achieved using a new range of hard facing welding electrodes introduced by Quasi-Arc Limited, of Bilston, Staffs.

Cobalarc electrodes, added to the existing group of seven Duroid electrodes, provide a complete range of hard facing products which can be applied to almost any type of plant subjected to wear.

The six types of Cobalarc electrode are graded according to the properties of the deposit, with resistance to maximum abrasion at one extreme and maximum impact at the other. The deposited alloys include tungsten carbide composites, chromium carbide austenitic irons, cobalt and nickel base alloys, and martensitic, pearlitic and austenitic steels.

Diameters of the tubular Cobalarc electrodes go up to a maximum of $\frac{7}{16}$ in, and special moisture-proof coverings enable them to be stored under any conditions. The electrodes can be used with any conventional a.c. or d.c. welding power source and are equally suitable for use in shops or on site.

How the Aeroplane is Helping the Farmer

At the recent International Agricultural Aviation conference, held at the College of Aeronautics, Cranfield, Beds, several aircraft designed for use in agriculture were demonstrated.

The use of aircraft in agriculture dates back to the 1920's, when some war surplus aircraft were used to dress cotton plantations in the United States. Despite this early start, the application of aircraft to farming is still in its infancy, although it is known to be an important means of increasing food production to meet the needs of a growing population. There is, in fact, no limit to the uses to which aircraft can be put in relation to farming and new applications are being found nearly every day.

Unfortunately our own island, and indeed most of the countries in Europe, provide some of the most difficult areas for the use of aircraft. The small north-south extent of the countries means that seasonal work occurs almost simultaneously across the land mass. On larger continents the delay between north and south areas (plus the wider variation of crops) assists the agricutlural aircraft operator. The seasons can be followed as the year progresses and there is sufficient work to occupy most of the year. One of the duties of the European Agricultural Aviation Centre is to try to get some coordination between the national operators to improve their economic situation. Thus, although the north-south extent of Europe is not as great as that of some other continents, it should be possible to make the most of the situation.

The Auster "Agricola" shown in the act of spraying from the comb-like attachments underneath its wing.

The Czechoslovak L-60 "Brigadyr," a high-wing machine equipped with slots and flaps for slow flying.

Despite the disadvantages at home, British companies concerned in the business are well to the fore in both equipment and methods. What is more, they have substantial backing from both the aircraft and equipment manufacturers. All this was obvious at a recent demonstration of aircraft, and equipment, intended for agricultural use, given at the end of the first International Agricultural Aviation Conference, held at the College of Aeronautics, Cranfield, Beds.

A comprehensive selection of aircraft was shown there, including examples from Canada, America, France and Czechoslovakia. Significantly all the aircraft and helicopters from abroad were standard designs modified for agricultural use. This is considered a good feature in some circles, because initial cost is lower on account of mass production. Also the aircraft can be used for other purposes once the special fittings are removed. The problem of first cost is a very important one for this type of aircraft and no manufacturer can ever meet the low cost desired by operators. To date the industry has been spoilt, for it has grown up since the war using war surplus equipment. Trainer and liasion aircraft were purchased cheaply and because huge stocks of spares were available, they were equally cheap to operate.

The present position is that nearly all the aircraft and spares have been used up, so new aircraft must be bought. To meet the probable needs of operators, the British aircraft industry is offering no less than three basic designs, plus two conversions of existing types. One of the new types is the Auster "Agricola" which has been designed specifically as a dressing aircraft. Considerable on-the-spot research was carried out by the Auster design team and test pilots to make sure that these machines are properly engineered for the work. In this respect alone, the "Agricola" airframe represents a great advance on tne converted trainer or adapted light plane. A batch of these machines has been completed for the New Zealand Government. Another type (from the same firm) is the "Workmaster," a general purpose design which can be adapted very quickly to the needs of most farming operations. Several have already been sold at home and abroad.

Another British design specifically for the agricultural operator is the "Prospector," manufactured by the Lancashire Aircraft Company Limited. In much the same weight and power category as the "Agricola," it differs in that it was designed for the more general farm work, rather than for a specific purpose. Thus it can be used as a light transport for men or animals, for small freight or for supply dropping to marooned flocks and farmsteads. It is quickly converted to a sprayer or duster by fitting the equipment carried in the capacious hold.

An interesting machine flown over from Czechoslovakia was the L-60 "Brigadyr." It is a high-wing machine fitted with slots and flaps to allow very slow flying speeds. This is a great advantage for this class of aeroplane as it often has to fly close to trees, pylons and other natural hazards. Because of the low altitude at which the aircraft fly while dressing crops or dropping fertiliser, the operation calls for consummate skill on the part of the pilots;

Spraying from a de Havilland "Tiger Moth." The man is acting as a marker.

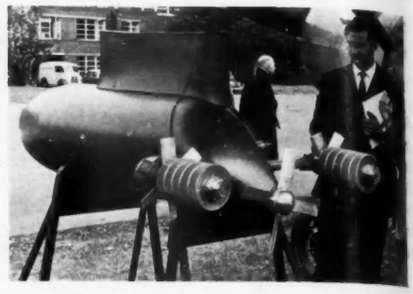
After topping up, this Hiller helicopter flicks its tail up for a quick get-away.

unfortunately, the accident rate is high and special attention must be paid to accuracy of control and crashworthiness during the design stages. Whereas the majority of crop-dressing aircraft use wind driven pumps to deliver fluid to the spray bars, the "Brigadyr" has an engine-driven unit. This is an important refinement on such a slow flying aircraft, for it means that delivery rate is independent of air speed. Also there is no windmill drag to slow the aircraft and impair take-off at full load.

Other machines demonstrated included several helicopters, of which the most interesting was the French S.O. Djinn. Powered by a small jet engine which provides air under pressure to the rotor tip jets, it showed itself to be extremely agile and capable of very accurate control. Features of this type are the very low maintenance costs, compared with other helicopters, and its simplicity of operation.

As well as offering a good range of aircraft, the British industry can also supply specialised equipment. For example, the Micronair rotary atomiser is an efficient airborne atomiser, which can be adjusted to give the most efficient droplet size for the particular crop being treated. The exceptionally fine mist that can be produced penetrates the foliage to give an even and sufficient spread. The spray is carried downwards by the relatively slow vertical velocity of the wing downwash. For most operations this is to be preferred to the more severe blast produced by helicopter rotors.

In the past these atomisers have been carried on aircraft as special fittings, two or four being attached to a machine, depending on its capabilities. A new device shown by Britten-Norman Limited, Ryde, Isle of Wight (the makers of the Micronair equipment) consists of a detachable pod which carries two atomisers. These pods, which are integral units providing tankage for up to 75 gallons of fluid, can be fitted to practically any aircraft for spraying work at short notice. They pick up on standard supply or bomb carriers and so it will be possible for governments to use military aircraft to fight locust swarms and the like. This development was undertaken at the request of a body known as Desert Locust Control and most certainly marks an important step in the growth of aviation for agriculture.



The Micronair atomiser pod for fighting locusts.

CONVEYOR BELTS FOR MOVING PEOPLE

Moving pavements, speedwalks and travolators: these are some of the names used on both sides of the Atlantic for conveyor belts specially designed for the mass movement of people.

Conveyor belts, even rubber-coated ones, are not new and can be traced back to the end of the last century. But those were concerned with coal, earth, ore, boxes, animals, etc., not with human beings. In the United States there are at least two dozen passenger-carrying conveyor belts, some long, some short, some moving upwards and some moving downwards. This is not many but the point is that they are in service and are gaining wide acceptance.

In Europe, progress in the development of passenger-carrying conveyor belts, although slower, has been steady. At the Bank station in London, a twin-track "travolator" is being constructed to carry 40,000 people a day through a 300 ft tunnel at a peak rate of 800 a minute.

Germany is well aware of the need and effectiveness of this form of mass transportation and new city plans incorporating passenger conveyors were published several years ago. In Sweden the Sandviken Steelworks installed a passenger conveyor at its works towards the end of last year.

American experience with passenger-carrying conveyor belts is based on the use of specially designed and strengthened rubber belts. Reinforcing materials have made marked headway in recent years and include rayon, nylon and glass fibre, as well as cotton and steel cables but passenger conveyors are still in the experimental stage, and there is as yet very little standardisation.

American manufacturers seem to favour 24 in belt widths for single line traffic and one leading company at least is using a band speed of 132 ft per min. Based on a 24 in wide rubber belt, this assumes that the average passenger weighs 150 lb and a passenger spacing of 2·2 ft per lane.

European experience, as reflected by the work carried out in Sweden by the Sandvik Steel Company, is basically different from that being undertaken in the United States. This is mainly because that company pioneered the manufacture of rubber-coated steel band conveyors, which have been operating successfully in coal and iron ore mines for some years. It was only natural, therefore, to use rubber-coated steel band for the mass movement of people. Work on the project led the company to design and equip its works with a complete moving sidewalk installation. This was essential for the investigation (under actual working conditions) of belt thicknesses, appropriate coverings, idler spacings and a hundred-and-one other details.

It is firmly believed that there will be a lot more moving side-walks in Europe in the next few years. The Sandvik Steel Works have already received five orders for moving side-walk installations in various parts of the world.

ENGINEERING EXHIBITION AT BRNO IN CZECHOSLOVAKIA

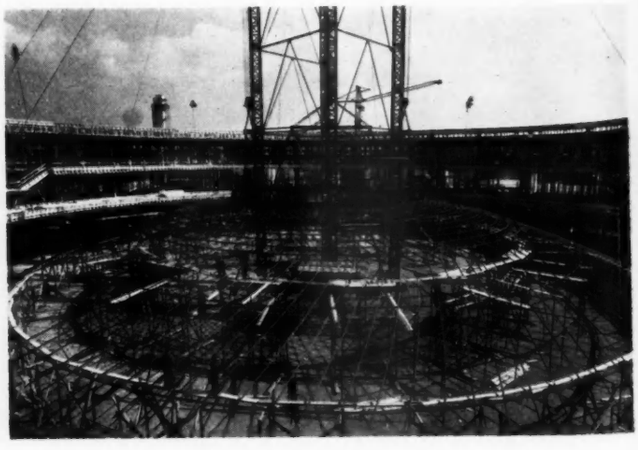
Visitors to the recent engineering exhibition at Brno, Czechoslovakia, were impressed by the efforts to develop a site worthy of international exhibitions. The fair ground covers some 120 acres and with 12 exhibition halls, suitable open spaces, restaurants and seating arrangements, the organisers can cope with more than 100,000 visitors a day. Buildings completed this year include a ten-storey administration block with observation tower and the large pavilion (Fig. 1).

The steel dome has a lattice shell of stainless steel tubes and a diameter of 306 ft. The dome was partly assembled on the ground, progressing from the centre to a diameter of about 240 ft. The structure was then lifted by the four assembly masts passing through the centre of the dome (Fig. 2). To complete the full diameter, circumferential scaffolding was used.

The Czechoslovaks are making an earnest effort to become a recognised centre for engineering trade fairs and may well succeed.

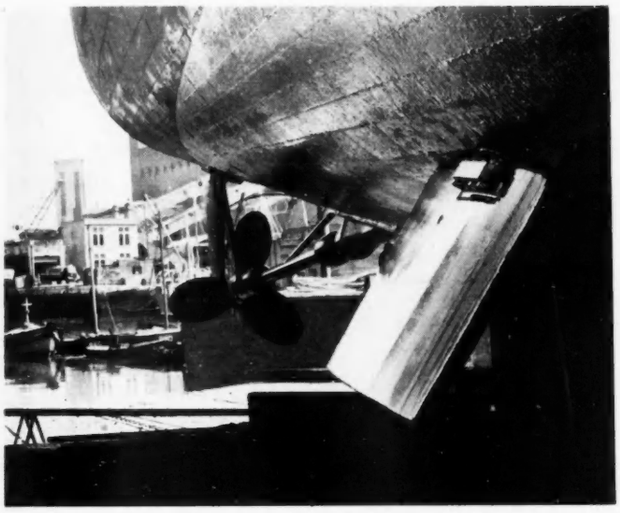
Fig. 1

Fig. 2



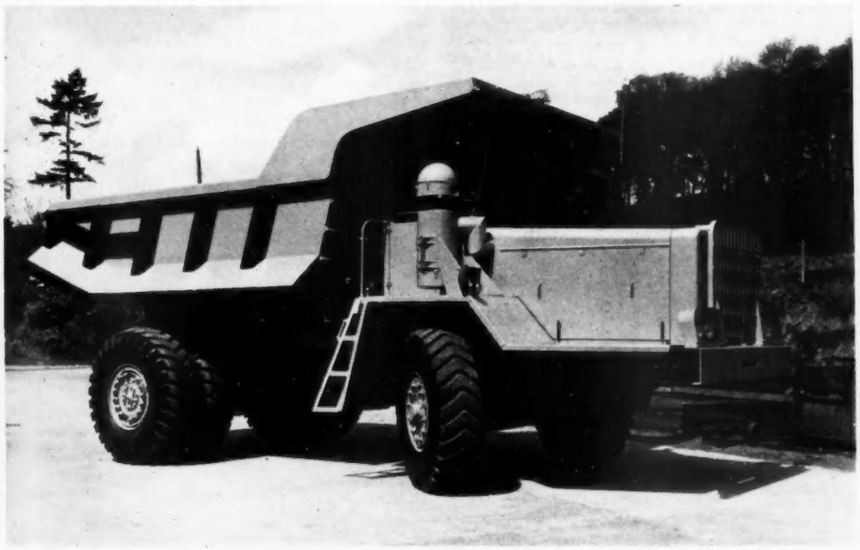
US module with two sets of eight transistor elements in a "window-frame" of aluminium.

Westland Aircraft have put forward designs for a three-way lift helicopter to be used as an aerial crane, a short haul transport (as here) or to convey utility pods for specialist roles such as operating theatres.

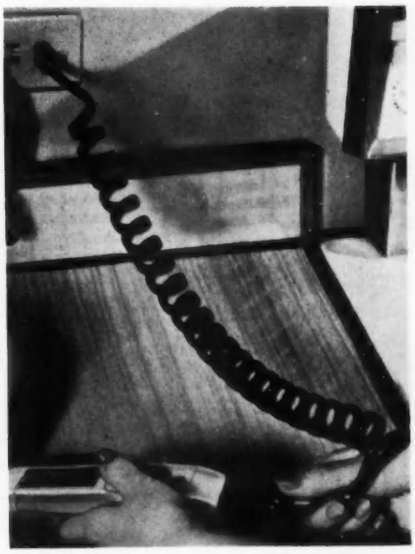


View showing Vosper roll damping device fitted to the hull of HMS Coniston. It is a simple, unflapped fin of symmetrical section with a low aspect ratio.

Transparent dome skylights, made from large single sheets of acrylic plastics by Rohm and Haas, for a school in Grand Rapids, Michigan.



18 cu. yd AEC Dumptruk is fitted with Edbro tipping gear using twin ram 3-stage equipment giving a 70 degree angle of tip. A control valve operated by the driver gives: lift, hold, power down and float.



This Du Pont neoprene-jacketed heater cord, for use with small kitchen appliances, will not tangle.

SWITCH NEEDS LITTLE HEADROOM

A float switch has been developed by Megator Pumps and Compressors Limited 43 Berkeley Square, London, W1, the whole unit (switch, float gear and counterweight) forming a single assembly for mounting. Very little headroom is needed since it can be mounted near the upper water level and still cater for a large rise and fall, because of the way the float gear has been designed. A flat nylon belt is used instead of the usual wire rope. This allows the actuating stops (or fingers) that engage the switch trip-lever to be mounted on the upper side of the belt, to pass over the pulleys in operation.

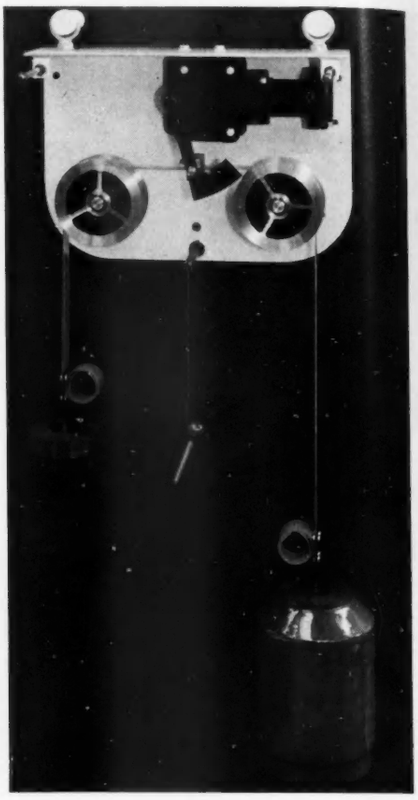
The design is rugged, the switch and pulleys being protected by a strong welded-steel cover. A BSA Acme Snap-lock switch is used, and this may be a Buxton certified type for Groups I, II and III gases or with a normal water and dust proof enclosure. A safety locking pin is built-in, to prevent accidental energising of the circuit during maintenance.

The pulleys are of bronze, mounted on Fluon-impregnated bushes. A 20 ft nylon belt is supplied as standard, punched at 3 in intervals for easy adjustment of the switch actuating fingers that determine the operating levels.

The float, which is corrosion and puncture proof, is made of expanded polystyrene with millions of separate water-tight air cells. It is encased in glass fibre for protection.

There is a single-pole switch, with silver contacts, rated at 10 amps, 440 volts a.c. The flame-proof version has a single-entry sealing chamber, and a gland for armoured cable. The weather-proof switch is tapped for $\frac{3}{4}$ in conduit entry.

Dimensions are: depth 6 in; height 13 in.



CONTACT WELDING ELECTRODE

A contact electrode, Type C16 (Philips Electrical Limited, Century House, Shaftesbury Avenue, London, WC2), was specially designed for trouble free, rapid contact welding of all mild steels and low alloy steels, in downhand, standing fillet and horizontal-vertical positions. The first class mechanical properties and X-ray qualities of the welds so produced makes them suitable for the demanding conditions of nuclear engineering, where safety depends on high standards of workmanship.

The electrode is zircon iron-powder coated, intended for easy contact welding and giving weld metal better than low-hydrogen methods.

TEST DATA

Typical data obtained from Type C16 all-weld-metal specimens deposited according to B.S. 639: 1952, are:—

Yield point	27 tons per sq. in
Maximum stress	34 tons per sq. in
Izod impact value:	
at room temperature ..	85 ft-lb
at − 20° C	80 ft-lb
Elongation on 3·54 dia ..	36 per cent
„ „ 8 dia ..	29 per cent

REINFORCED PLASTICS FOR SPORTS CAR BODY

Bakelite polyester resins, reinforced with glass-fibre, have been used for the bodywork, flooring and many components of this custom-built sports car made by Layton Sports Cars Limited, Layton, Blackpool. Called the TVR Grantura, the car is capable of speeds of 100 m.p.h. plus and has been designed to combine the comfort of the larger type of saloon car with a machine suitable for competition racing.

Reinforced polyester resin for bodywork and flooring was chosen by the designer (Mr. Trevor Wilkinson) to overcome the weight problem of sports cars and so that production could begin with the lowest tooling costs. Over 20 separate parts, from the differential housing cover to the bucket seats, are made from glass-fibre reinforced polyester resin and this meant that modifications were easy to carry out during the development period. Other important advantages of the material are: excellent strength-to-weight ratio; non-corrodible properties; good appearance; ease of repair; and shock absorbing properties, a particularly important safety feature in high-speed automobiles.

Over 3½ years of development work went into the Grantura. The first stage took place in the US when three prototype chassis were sent to Ray Saidel, a well-known figure in American racing circles, to be fitted with a racing type body. Although this step was taken mainly to evaluate chassis performance, the car was raced on many occasions and several class wins and places were obtained over a 12 month period. Subsequently, a number of prototype bodies, all based on this polyester resin, were designed and constructed in the United Kingdom, until the present coupe body was finally chosen.

As part of their plan for entering the international racing field in 1960, Layton Sports Cars Limited entered the Grantura in recent competitions in the north of England, and won several times against strong fields of well-known British and Italian sports cars. A feature of these wins was the speed and excellent road-holding properties of the car.

The TVR Grantura has independent front and rear suspension, tubular chassis and light-alloy bumpers and fitments. Two models are available: one is powered by a Coventry Climax 1,220 c.c. engine and the other by a Ford 100E engine fitted with Shorrock supercharger.

Installing the engine of the Grantura, two models of which are available. The car was designed to combine saloon car comfort with racing car performance.

Preparing the car for painting. The bodywork, flooring and more than twenty other parts are made from glass-fibre reinforced Bakelite polyester resin.

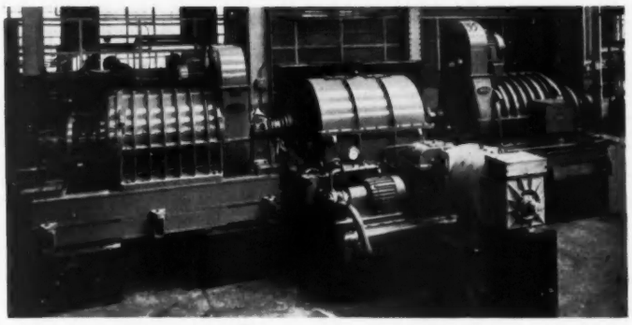
TESTING LARGE HIGH-SPEED MOTORS

Because of the present day trend in power station practice, which favours the use of larger generating units, there has been a corresponding increase in the demand for larger boiler auxiliaries, including boiler feed pumps up to 10,000 h.p. This has resulted in the design and construction of 2 and 4-pole induction motors larger than hitherto contemplated. As reliability is essential in all power station plant it has become necessary to provide for stringent full power tests at the manufacturer's works, and to meet this need, the General Electric Company Limited, Kingsway, London, WC2, have developed new test plant. The equipment, for which a patent application has been made, is a variant of the back-to-back system, in which the only power required is that needed to meet the mechanical and electrical losses.

If very large induction motors were submitted to full-load tests in which the energy was dissipated wastefully, very complex problems would arise. To load a 10,000 h.p. machine fully, for example, would require a power supply of 9,000 kVA, and to dissipate this amount of power would be difficult and costly. The use of a differential gearbox overcomes this problem.

An induction generator only delivers power when it is driven above its synchronous speed. To operate a back-to-back test, means must be provided to give the required difference in the speeds of the two machines being tested. This is achieved by using an epicyclic differential gearbox in which the slip energy is provided by a variable speed d.c. motor feeding into the planetary gear of the unit. Made by David Brown Industries Limited, Huddersfield, the gear unit is continuously rated for 10,000 h.p. at 3,000 r.p.m. with a maximum shaft differential of 100 r.p.m. It is built as a self-contained unit with its own water cooled lubricating system. The maximum rating for the slip energy motor is 200 h.p. at 1,500 r.p.m. The gear unit can be seen, together with the 1,500 r.p.m. Ward Leonard controlled d.c. motor, in the accompanying illustration, which shows two similar large 2-pole induction motors under test.

Driving the differential shaft creates a speed difference between the motors by adding revolutions to one and subtracting them from the other. In effect, one motor is braked and develops a torque, while the other is accelerated, absorbs the torque and delivers power as an induction generator. The loading on the machines is directly proportional to the rotational speed of the differential shaft. Only the slip energy or the rotor losses are provided by the differential shaft motor, and the only power taken from the supply is that required to cover the stator losses.



Developed by the General Electric Company Limited, this motor testing unit can deal with high speed induction motors or, with a small modification, with synchronous machines.

The gear unit can be used for testing any similar pair of motors provided that their output is reasonably high compared with the gear losses. It is estimated that motors as small as 300 h.p. at speeds up to 3,000 r.p.m. could be tested satisfactorily.

Synchronous machines can also be tested by coupling a hand-operated gear unit to the differential gear train in place of the driving motor. A synchronous motor coupled to one main shaft and running at synchronous speed would not necessarily be in phase with a similar machine coupled to the other end when connected to the same supply, but the machines can be brought into synchronism by rotating the hand-operated gear unit. When similar machines have been synchronised, the loading on them can be increased by rotating the hand gear unit, which causes their mechanical displacement to alter.

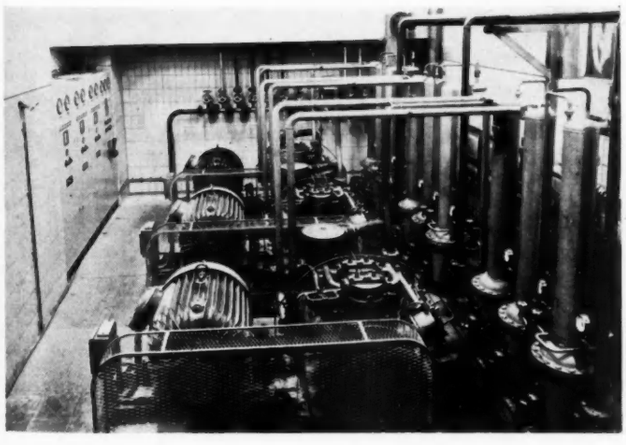
One machine becomes a synchronous motor and the other a synchronous generator, which feeds power back to the supply. The particular role played by each machine is dependent on the direction of rotation of the hand gear unit, and the actual loading on each machine is a function of the degree of mechanical displacement produced. An important feature of this testing unit is that, in the event of a sudden removal of the electrical load, the mechanical displacement between the machines remains unchanged, and the load can be reapplied without having to synchronise the machines. This is particularly advantageous when testing synchronous machines which are controlled by automatic voltage regulators.

COMPRESSED AIR IN A POWER STATION

A particularly comprehensive compressed air system which provides power for a variety of operational and maintenance duties, has been installed in the latest electric power station to be opened in the Netherlands. The power station, in the Utrecht area, has been built by Provinciale Germeentelikj Utrechts Stroomleverings Bedrijf (Pegus), and has at present two turbines each of 63,000 kW capacity; it is designed for future enlargement.

More than 35,500 cu. ft per hour of compressed air are used, for regulation of the turbines, to provide a compressed air safety curtain over the inspection doors on the liquid ash draining equipment on the boiler plant, for controlling the turbine hall windows, for operating pneumatic tools for maintenance, and for other purposes. All the compressed air required is provided by a central compressor installation supplied by Grasso Koninklijke Machinefabrieken, NV, 's-Hertogensbosch, Netherlands.

There are three compressors of the water-cooled, two-stage type, with intermediate and final-stage coolers (including oil and moisture separators). They are of all-welded construction, the cylinder blocks being welded in W-shape to the cylinder frame. Wet type cylinder liners are fitted, and the cylinder heads are water cooled. Pressure lubrication is provided by a gear pump fitted on the back cover of the frame and driven off the crankshaft. The compressors are designed for constant speed operation. When the pressure rises to a preset maximum, an unloader operates and the machine continues to run at normal speed with minimum power consumption. When the pressure has dropped by approximately 7 lb per sq. in, the unloader returns to normal and compression recommences. Setting is possible over a range from 115 to 220 lb per sq. in, the normal operating pressure being 115 lb.



Three automatically controlled air compressors supply the power for turbine control and other services in the latest Netherlands power station.

All three compressors are under fully automatic control from a panel mounted in the compressor house; it was supplied by the compressor manufacturers. An automatic warning system incorporated in the control panel gives protection against dangerous variations in the compressor cooling water and oil pressures, and in the temperature of the cooling water. Audible warning is given that attention is needed, and a signal lamp adjacent to the appropriate meter indicates the source of the trouble. This safety system also comes into operation if, for instance, through a power failure, the air pressure, which is normally 115 lb per sq. in, drops below 75 lb per sq. in.

£2½ MILLION TINNING LINE ORDERED

A tinning line to operate at a greater speed and a larger output than any existing similar line is the subject of a contract which has been awarded to the Head Wrightson Machine Company Limited, a subsidiary of Head Wrightson and Company Limited. This electrolytic tinning line, which is valued at over £2 million, is for installation at the Ebbw Vale works of Richard Thomas and Baldwins Limited. It will be built at the manufacturing company's works on Teesside and is planned to tin and recoil 15,000 ft of steel strip per minute. In addition, equipment is being supplied for the preparation of steel strip before it is processed in the tinning line, for tin plate cut-up lines and for equipment to inspect and assort the plate.

Delivery is expected to take 18 months. The equipment is being designed in collaboration with the Aetna Standard Division of the Blaw Knox Company of America with whom the Head Wrightson Machine Company have been associated for several years.

The electrolytic tinning line applies very thin coatings of tin to coils of steel strip which have previously been cold reduced and tempered. It will accommodate strip varying in thickness between 0·0006 and 0·024 in and varying in width from 18 to 38 in. Coils weighing up to 36,000 lb will be used on the line. The equipment is to be designed to work continuously and to deposit a tin coating of 1 lb per basis box (a basis box is an area of 62,720 sq. in) at 1,125 ft per minute, but with lighter coatings at correspondingly increased speeds.

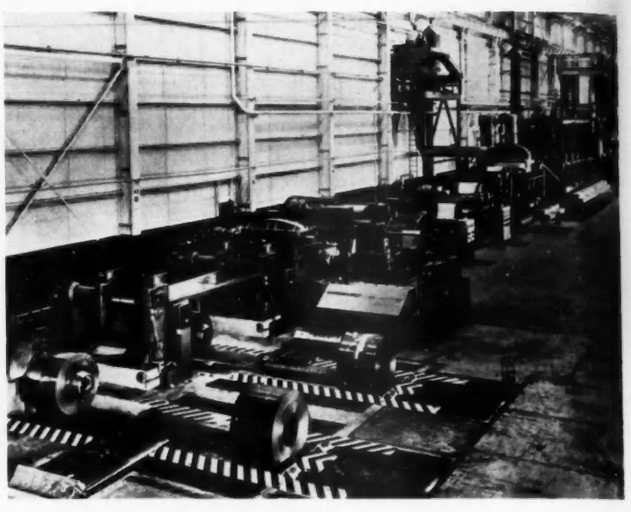
The low voltage current for the plating operation, some 180,000 amps, is supplied through germanium rectifiers. Automatic current control will ensure that the current will vary with strip speed so that the coating remains uniform.

The coils of strip to be coated are placed in one or other of two pay-off reels, continuous operation being achieved by welding together the ends of successive coils. A strip reservoir to be built into the line consists of three deep loops. It enables the shearing and welding operations to be carried out. The strip leaving the looping section is cleaned in an electrolytic degreaser and prepared further in an electrolytic pickler before being rinsed and scrubbed. It is then ready for passing through the vertical plating tanks in which the tin is deposited electrolytically, the plating current being transferred through a heavy busbar system from the rectifiers to tin anodes arranged on both sides of the strip. The return path is through conductor rolls in contact with the strip. After plating and drying, the coating has a dull matt finish. Brightness is achieved by electric resistance heating of the strip which "flow melts" the tin coating evenly over the surface and improves the quality. When differential coatings are being produced, a rotary printer is used to readily identify the heavier coating. The next operation is quenching in water followed by chromic acid treatment which prevents discoloration.

After drying, the tinplate is oiled as a protective measure and to facilitate subsequent forming operations. The material is then recoiled on a tension reel, two of which are provided to give continuous operation. A snip shear severs the strip on completion of a coil and, at the same time, the oncoming material is diverted to the empty reel.

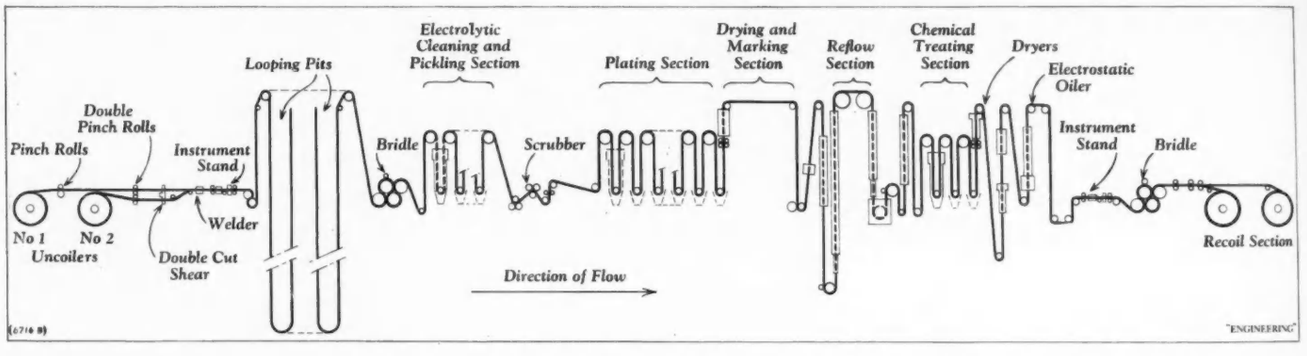
Before being plated, the coils are processed on a coil preparation line which can run at speeds of up to 4,000 r.p.m. The action of this line is essentially one of uncoiling, edge trimming and recoiling, in order to produce strip of accurate uniform width. Because it is desirable to feed the tinning line with coils of maximum possible length, wound so as to keep the number of stoppages for welding on this line down to the minimum, the preparation line is fitted with shearing and welding units to build up smaller coils where necessary. A thickness gauge is also provided to detect off-gauge material, which usually comprise thick ends arising from the rolling operation. This material is subsequently sheared and recoiled on a separate tension reel.

Finished coils of tinplate are passed to a shearing line to be cut to length. The material is uncoiled from a pay-off reel and is passed through a flying shear which operates at 1,000 ft per minute and produces sheets from 18 in to 43½ in long. Ahead of the shear there is an instrument stand fitted with a thickness gauge and pinhole detectors. Sheets are then automatically sorted and piled in a four-pile classifier arranged with two prime piles, a reject or pinhole pile, and a menders pile. The menders pile of sheets usually contains, in addition to off-gauge material, sheets of poor appearance which are reclaimed for further treatment on an inspection and sorting line.



(Right) A tinning line constructed by Blaw Knox of America and similar to the new plant on order for Richard Thomas and Baldwins for their Ebbw Vale works. The new line is to be built by the Head Wrightson Machine Company.

(Below) A schematic diagram of the new tinning line which is to be installed at Ebbw Vale.



COMMONWEALTH STANDARDS

Much useful progress towards the greater alignment of their industrial standards is reported to have been made by the seven countries which took part in the recent Commonwealth Standards Conference in Ottawa. The conference included three technical sessions on steel, air receivers and cranes.

At the steel session, there was an encouraging review of the progress made since the 1957 conference in Dehli in implementing the recommendations then made about standards for cold formed light gauge sections.

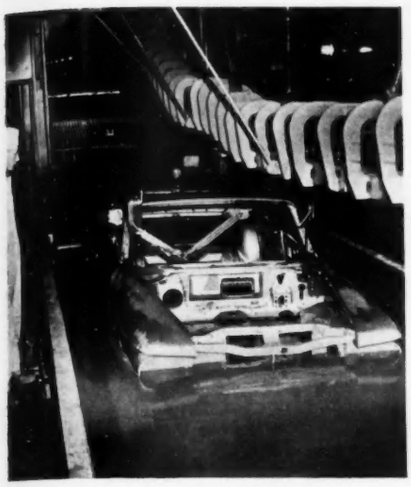
A useful discussion was held on the need for re-designing hot rolled steel sections in order to gain more efficient use of the steel. Note was taken of the important developments taking place in techniques of steel production in all parts of the world, and it was therefore felt that it would be premature to decide what the new designs should be until future steel mill practice became more clear.

In India, much thought had been given to the special problems involved in standardising sections on a metric basis; and, in the light of their experience the Indians had undertaken to submit suggestions for re-designing sections on the inch system.

The desirability of coordinating specifications for wrought carbon and alloy steels was also considered but no clear pattern emerged as to the basis on which this might be done. Interchange of information on this subject will continue.

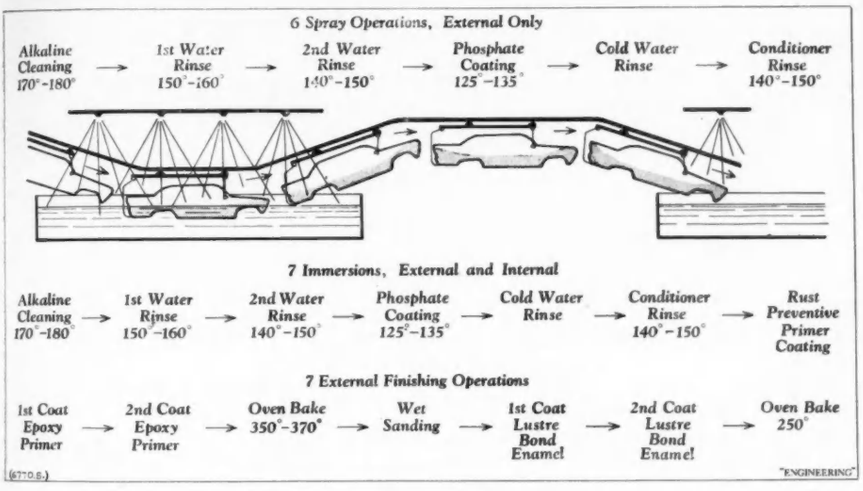
Production

FINISHING CHRYSLER CAR BODIES



Resulting from four years of research and 250,000 miles of test driving on water-splashed chloride-treated roads, the Chrysler Corporation of Detroit, USA, has introduced a £6 million body finishing system at its various body plants in the United States. The system is an electronically controlled method of cleaning and drying, heating and cooling, rinsing, priming, and painting. It gives full protection to every part of the car body, which is subjected to nine different temperature changes, three metal-cleaning baths, seven anti-corrosion dips, seven spraying operations, and seven external paint-finishing operations. The operations are enumerated in the accompanying diagram.

Sixty cars per hour pass through the system, and during peak production periods, 16,800 gallons of primer are used daily. A strict routing of testing the temperatures of liquids and the composition of the chemicals used at each stage of the operation is claimed to ensure a hitherto unparalleled standard of rustproofing.



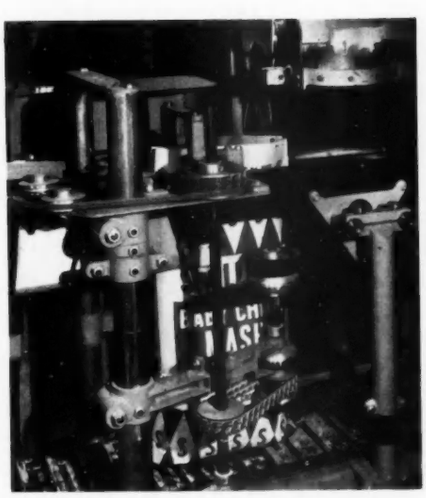
SEALING SACKS

Claimed to be the first British machine of its type, is the Automatic Sac-Sealer made by Medway Paper Sacks Limited, Larkfield. The machine transfers the filled paper sack from the filling point to the sewing head and controls the sack mouth prior to the sewing operation, feeding it into the head for sealing.

As the sack moves along the conveyor from the filling point, a series of adjustable forming rollers manipulate and redistribute its contents, overcoming bellying and distortion of the sack gussets. The moulded sack then enters the closing section, where the gussets are closed at the top and the lips are aligned ready for sewing.

It is reported that the machine enables one operator—without extra effort—to produce the output for which two operators were previously needed, and also that mis-stitching is virtually eliminated, thus reducing sack burstage.

Full-scale tests have been carried out on the packing of animal feed meals in ½ cwt units, and further development is now being conducted into its application for ¼ and 1 cwt units of other materials.



A general view of the sack sealer, in which the guard has been removed to show the tapered rollers and guide belts which form the sack mouth and feed it into the sewing head.

Marketing

Life of a Salesman

The function of a specialist salesman, operating from headquarters and bringing his own intimate knowledge of the application of his company's products in nuclear engineering, was described by himself in a delightful little sketch published in the summer number of George Kent's magazine. The man is Mr. R. Wrightson, his job designation is "special sales representative to the nuclear energy industry" and the title of his article "Selling to Nuclear Energy." He sells his company's instruments to the United Kingdom Atomic Energy Authority (alias "the Authority," alias "Uke") who employ 30,000 people, and within this organisation separately to the Research, Weapons, and Industrial groups. Then he has five major industrial customers, the nuclear power station consortia, "each of whom is organised to design, manufacture, erect and commission nuclear power stations at home and abroad." Finally Mr. Wrightson has a long list of firms who supply plant and equipment to the authority and to the consortia, some of them designing nuclear reactors for special purposes, such as for research or marine propulsion.

Mr. Wrightson's job is to sell as much Kent equipment to these firms as possible, "preferably standard." He writes about the mechanics of his job, such as making appointments, complying with security regulations, seeing "up to six or ten people" at places such as Harwell or Aldermaston, wearing white overalls and radioactivity measuring devices, and so on. His aim: "to follow up quotations ensuring previous customers have up to date information on our products and generally maintaining contact on a broad front." An ordinary job which, he says, "can never for a moment be called dull," in an industry which is anything but ordinary.

Data for Exporters

A booklet entitled *A Simple Guide to Prospective Exporters* has been published recently by the Gauge and Tool Makers' Association (*3s 6d* post free on application to Standbrook House, London, W1). The subjects dealt with include representation in foreign markets, the appointment of agents, documentation, methods of payment, and other basic information.

The association state that the object of the booklet is "to assist firms without previous experience in overseas trading in the commencement and development of an export business," and that further information will be given in particular cases.

Transatlantic Spray

The extension of import arrangements in respect of American products is a logical consequence of the strengthening of sterling *vis-à-vis* the dollar. In cases where the large scale production of United States firms enables them to be competitive in this country such arrangements have a distinct advantage over those which cater for manufacturing under licence and must be expected to grow over the next few years. One of the more recent is the agreement between Alfred Bullows and Sons Limited of Walsall and the Gray Company Incorporated of Minneapolis, whereby Bullows have sole distribution rights in the United Kingdom for the complete range of Graco industrial equipment.

The Graco range includes airless spray painting equipment, heavy material spray and extrusion equipment, and fluid transfer equipment of all types. All Graco pumps are air-operated and include models suitable for the handling of fluids and semi-fluids, from inks and paints to heavy mastics and putties. They are already widely used by the motor industry and will greatly add to the comprehensiveness of Bullows' own range.

Marconi at Ljubljana

Participation at trade fairs in underdeveloped countries is becoming essential for companies intending to supply these markets. In a world where the political motives of governments are gradually replacing profit or expansion motives of companies in determining export policy, individual firms can only assert themselves by the closest contact with the local users of their products.

Marconi Instruments Limited, who recently supplied £26,000 worth of signal generators to Yugoslavia, are exhibiting their latest telecommunication measurement equipments at the Ljubljana International " Modern Electronics " Fair which is being held in Ljubljana, Yugoslavia, from 16 to 25 October. Their exhibits will include a new general-purpose oscilloscope (TF 1330) and a range of voltmeters, including the TF 1041B which is the first instrument of its kind with a frequency range extending to 1,500 Mc/s. These instruments are good examples of the latest advances in the telecommunications field and Marconi's action suggests that countries in the early stages of industrialisation will require the most modern equipment and are less and less willing to buy designs which are becoming obsolete in highly developed countries. This will force many engineering companies to reconsider the whole basis of their export trade.

Boosting Air Sales

The success of the French aircraft industry in recent months owes a great deal to the energetic sales promotion of its products by their trade association, Union Syndicale des Industries Aéronautiques, and by the leading constructors such as Sud Aviation and Breguet. Considerable assistance has been given by the French Government. Last month, for example, the minister of public works and transports held a press conference at which he spent much of his time boosting the claims of two new French aircraft, the Breguet 941 (with blown wings) and the twin turboprop Max Holste 260, saying that the French government expected a " bright future " for these two machines.

Another example of government assistance is the display organised by the Exportation-Expansion Division of the French Air Ministry on 18 September for the benefit of India's minister of finance, Mr. Desai. The display, which was organised at the request of the Ministry of foreign affairs, included ground and flight exhibits of the "Alouette II and III," the Breguet " Alizé " and the G.A.M.D. " Mirage III."

Sud-Aviation's helicopter " Alouette " has already secured large foreign orders, from Germany (130), Sweden (23), USA (17) and Switzerland (10). The success of the " Caravelle " is well known: the first of a number ordered by the Brazilian air company VARIG was handed over on 15 September. An official inauguration ceremony for this aircraft is to be held at Brazilia, the new capital city now being constructed. There is something spectacular about the French aircraft industry's progress, doubtless based on the excellence of its aircraft, but the close commercial partnership between industry and government must be of considerable assistance in the marketing of a product mainly purchased by governments or public corporations.

At Home

HOUSE PLANS

The answers given by the Town and Country Planning Association to the questionnaire sent out by the Housing Standards sub-committee of the Central Housing Advisory Committee, make very interesting reading. They certainly seem to be founded on hard experience.

The tone is set by the answer to the second question: " As living standards rise, people increase the amount and widen the range of personal possessions. Not only do they buy television sets, radiograms, washers, refrigerators and cars, but they buy more clothes, furniture (essential and occasional), books, recreational equipment, toys, household linen, and a host of other commodities. More space is needed for the use and storage of these things, and there is far too little such space in the dwellings now being built." To put it quite plainly, present-day houses are much too small.

To this many people would agree. The family is such a basic unit in society that there must be reasonable provision for it to be a family and yet there must be reasonable accommodation for each member to have some degree of privacy. The open plan may look nice but it is quite impractical when there are children at home, for television, gramophone, woodwork, homework, and father's sneaked forty winks just do not mix. Therefore either there must be more than one living room or the bedrooms must be large enough to be bed-sitting rooms without that vague sense of impropriety that sometimes attaches to bedroom gatherings.

The growth of home hobbies also makes demands on space. A rich Axminster is not the best floor material when doing carpentry or photographic experiments. It is expensive too, to let the children riot among the Chippendale and Sévres—and in a town flat there is no garden or open space for play. Therefore—a play room, where chalks and paints do not matter and noise is isolated. Each child over 10 years should also have a separate bedroom and there ought to be a spare room for the occasional guest.

Taken in sum this is a plea for a return to the more or less conventional type of house that was built in large numbers a generation ago. But there is one room that will not be the same, a room that has seen more changes than any other and those changes mainly due to engineers. This is, of course, the kitchen. Taking the farmhouse type as the original, it has changed from a family living room where all met and ate and where life centred round the cooking range, to the underground horror of the Victorian era, through the minute version of the post First World War years (reaching its peak in the kitchen unit supplied for the single room in which cooker, sink and pantry were all squeezed into a single cupboard) and coming back of recent days to the so-called kitchen-breakfast room beloved of the house agent.

This last is undoubtedly a practical form for the present day—always provided that it is big enough. The Association list the following items that it will probably have to hold. " . . . washer, spin dryer, refrigerator, cupboard for all crockery, saucepans, brooms, vacuum cleaners, dusters, etc., etc., as well as an adequate sink unit, gas or electric cooker, and in most cases a boiler for water and central heating." A truly formidable list to which must be added a table for working on, a door to the larder (a separate walk-in larder is advocated), a door to the passage, possibly a door to the garden or side entrance, a window and of course floor space for the housewife. If, in addition, the family are expected to have at least breakfast there (a very reasonable arrangement and one that saves the eternal labour of carting crocks to and fro) then a little more floor space must be allowed. In fact it would seem to be a wonder that there is room for any other room on the ground floor.

But these gadgets are now regarded as essentials, as indeed they are in view of the virtual absence of domestic help, and they are not going to decrease in number. More and more are appearing every week. They are one of the fields in which the engineer can play a vital part in every day life, more vital even than many other activities, for a smooth running home means a contented workman.

Some years ago it might well have been asked: What has housing to do with engineers? Isn't it the job of builders and architects? But since the war the whole pattern has been changed. So much of the modern house comes ready made from the factory that the old rule-of-thumb construction should now be abandoned. When all the work was done on site it did not matter much if things were an inch or two out of square or plumb, it could nearly always be covered up by a bit more plaster, but with factory-made units, doors, windows and the like, the tolerances are cut down and errors are expensive to rectify. From his own point of view therefore the builder must exercise closer control on dimensions—another argument for a basically different form of construction.

Much expense in construction can be saved by proper planning of water and electrical systems. Central plumbing units made an appearance a while ago, units that can be factory made and simply erected on site to serve the various rooms. All these are engineer designed and built. Many yards of cable can be saved by planning the runs, and, most important of all, by installing a sufficient number of points at the outset. The later addition of more points, even with the ring system, can be very costly. Noise is another aspect for consideration—who has not been annoyed by next door's radio? Ventilation, air conditioning, single fire heating, all are definitely engineering problems and should be dealt with as such.

It is therefore very much up to engineers to study the housing report when it appears. Meanwhile the trend can be gathered from such information as the answers given by the Town and Country Planning Association that have been quoted here, and similar answers given by other bodies, such as the Federation of Registered House Builders. Apart from the mere considerations of size there are recommendations regarding lighting and power points, including shuttered sockets for safety, and general house heating. Finally, it is manifestly essential that " Houses and flats built to last sixty or one hundred years should not be out of date in twenty."

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